Minutes of the 25th

Meeting of the Board of Studies

Faculty of Engineering Sciences

held on

26th January, 2022

through VLC

Bahria University Islamabad

Contents

Minutes of the 23rd Meeting of Faculty Board of Studies Engineering Sciences held on 16th Mar, 2021 through Video Conferencing

Attendance:

BUIC

Prof. Dr. Atif Raza Jafri	Dean ES	Chair
Snr. Prof. Dr. Said Akbar Khan	HoD(E&ES)	Member
Snr. Assoc. Prof. Dr. Arif ur Rehman	HoD(CS)	Member
Snr. Assoc. Prof. Dr. Awais Majeed	HoD(SE)	Member
Snr. Asst. Prof. Dr. Shahzad Ahmed	HoD(CE)	Member
Snr. Asst. Prof. Dr. Junaid Imtiaz	HoD(EE)	Member

BUKC

Snr. Asst. Prof. Dr. Najam M. Amin	HoD(EE)	Member
Assoc. Prof. Dr. Salma Hamza	HoD(E&ES)	Member
Assoc. Prof. Dr. Syed Safdar Ali	HoD(CS)	Member
Assoc. Prof. Dr. Sohaib Ahmad	Associate Dean	Member
Snr. Asst. Prof. Dr. Rizwan Iqbal	HoD(CE)	Member
Snr. Asst. Dr. Osama Rehman	HoD(SE)	Member

BULC

Snr. Asst. Prof. Dr. Khawaja Qasim Maqbool	HOD(CS)	Member

Proceedings

Preliminaries

FBoS-ES meeting took place on 26th January, 2022, with the quorum complete, the proceedings commenced at 1030 hrs, with recitation from the Holy Quran.

In his opening remarks, the Chair stressed the importance for participation in the proceedings while staying focused on the point under deliberation.

New Items:

Item2501: Attendance issue of Fee Defaulters on CMS portal
Sponsor: HoD (EE) BUIC Referral Authority: DBoS EE BUIC

Summary of the Case

- Currently, faculty members are not allowed to mark the attendance of the fee defaulters on the CMS portal unless the fee issue is resolved.
- The attendance of fee defaulters during a running semester is managed by the concerned faculty member once the portal is open.
- It has also been observed that mentioning of fee defaulter on portal becomes an embarrassment for the student in front of the whole class, as in some cases the student is of under privileged background and needs financial assistance.
- Moreover, opening of portal for back date attendance creates confusion & agony for the faculty member too as sometime those students who are not genuine cases of fee defaulters, approach the FM to mark his/her attendance.

Discussion

• The sponsor presented and reiterated the agenda point, after detailed discussion and deliberation the house suggested that an IT solution is needed and attendance of student may be marked but that attendance may not be visible to student for the period of non-payment period until fees is paid.

Decision 2501

The case to be forwarded for the approval in ACM.

Item 2502: Spare Week in a Semester for Activities
Sponsor: HOD (EE) BUIC Referral Authority: DBOS EE BUIC

Summary of the Case

- The exposure of the Electrical Engineering students to the practical life is required via various activities.
- Students need to go for industrial trips, attend talks by the professionals from industries & academia and, attend grooming sessions etc. Such activities are also encouraged by PEC and has a considerable impact on the accreditation status of a particular program.
- These activities require dedicated time, and it is recommended to spare a week in a semester for such useful activities. Furthermore, LDC arranges activities as well (and forces Department to send students as Monthly report is to be sent to BUHO
- If such activities take place during regular teaching week, then the timetable of the students is disturbed & learning of the students is affected.

Discussion

The sponsor presented and reiterated the agenda point, after detailed discussion and deliberation the house suggested that planning of LDC activities. Faculty Development, Student Mentoring and student skill development activities should be done before semester.

Decision 2502

Point dropped.

Item 2503: Activity Based Assessment of the Courses mapped on Affective Learning Domain
Sponsor: HoD (EE) BUIC Referral Authority: DBOS EE BUIC

Summary of the Case

- Various non-technical courses for enhancing the communication skills of Electrical Engineering students have been proposed in updated roadmap 2018 (Ref: 32nd ACM).
- Such courses are impactful in grooming the personality traits of Electrical Engineering Graduates. Due to their nature, some of the courses differ in both their conduct as well as assessment methodologies. The student assessment of such courses needs to be based on demonstrated ability of students to perform different tasks.
- The CLOs of these courses are mostly mapped to the Affective Learning Domain, due to the nature of such courses and are approved by the Cluster Heads & DBoS committee.
- As the titles & CLOs of such courses suggest, any written assessment tool for this course would not be appropriate. The assessment needs to evaluate the ability of students to perform different tasks.
- Previously, such an agenda item has been approved for 'Oral Communication' course in BBA Program attached at appendage 2501.

Discussion:
- The sponsor presented and reiterated the agenda point, after detailed discussion and deliberation the house formed a committee under Dr. Awais Majeed with respective cluster heads as members to assess the CLOs of common courses (same course codes) and their assessment techniques and harmonize them across CUs. Departments is to send nomination. Report is to be presented in 26th FBoS.

Decision 2503:
Point dropped.

Item 2504: CQI Cycle for courses with students getting more than 20% A(s) or F(s)
Sponsor: HOD (EE) BUIC Referral Authority: DBOS EE BUIC

Summary of the Case
- As initiated by Dean ES Office, the courses with students getting more than 20% As or Fs were highlighted for Fall 2020 & Spring 2021 Semester attached at appendage 2502.

Discussion
The sponsor iterated and presented the agenda item, which was deliberated by the house in detail.
Decision 2504
Point dropped.

Item 2505 Corrections identified in Prerequisites of Electives Roadmap (2018) {Ref 32nd /22nd ACM}
Sponsor: HOD EE BUIC Referral Authority: DBOS EE BUIC

Summary of the Case
- Some corrections have been identified in the prerequisite courses of some courses in the Roadmap of BEE 2018 which was approved in 32nd ACM.
- Electrical Machines is mentioned by two Course Code **(EEN 219 and EEN 312)** in 22nd, 30th and 32nd ACM as attached at appendage 2503.

Discussion

The sponsor presented the agenda point which was deliberated in detail by the house. The house also suggested that Industrial Process Control is to be offered.

Decision 2505

Point dropped.

Item 2506: Interdisciplinary/Program/Stream Electives Selection for MS EE Program
Sponsor: HOD(EE) BUIC Referral Authority: DBOS EE BUIC

Summary of the Case

- MS Electrical Engineering offers specialization in 3 domains at BUIC and BUKC
    1. MS Electrical Engineering (Automation & Control)
    2. MS Electrical Engineering (Power Systems)
    3. MS Electrical Engineering (Communication Systems & IoT Networks)
- MS Scholars show interest in augmented research, e.g., power systems & control, IOTs & control (or other stream elective of MSEE)
- With reference to student handbook 2021 rule 1.20.7: "MS/MPhil scholars should be permitted to choose up to two electives interdisciplinary or from another domain in same program"

Discussion

HoD EE BUIC presented the agenda point which was deliberated in detail by the house. The house approved the offering of MS EE other streams elective.

Decision 2506

The case to be forwarded for the approval in ACM.

Item 2507: Roadmap of BS Remote Sensing & GIS, Department of Earth & Environmental Sciences, Karachi Campus
Sponsor: HOD (E&ES) BUKC Referral Authority: DBOS E&ES BUKC

Summary of the Case

1. The Department of E&ES (BUKC) has planned to introduce a new academic program, BS Remote Sensing & GIS (BS RS&GIS) as a 4 years degree program. The roadmap of BS RS&GIS program has been designed under the guidelines of HEC, inclusion of courses from clusters of Humanities and Social Sciences, distribution courses, elective courses and emerging market trends etc.

The roadmap and course details has been discussed with the faculty members and academic experts of D-BOS meeting held at Karachi Campus and with the faculty members of E&ES Islamabad Campus. The above said program was recommended by the DBOS.

The roadmap is presented at appendage 2504 for approval/recommendation in the forthcoming FBOS meeting.

Discussion

HoD E&E BUKC presented the agenda point which was deliberated in detail by the house. The house approved the agenda.

Decision 2507

The case to be forwarded for the approval in ACM.

Item 2508: Roadmap of MS Remote Sensing & GIS, Department of Earth & Environmental Sciences, Karachi Campus
Sponsor: HOD (E&ES) BUKC Referral Authority: DBOS E&S BUKC

Summary of the Case

In the light of recent market demands and emerging trends of technology in the domains of Earth & Environmental sciences, the department of E&ES has planned to propose program of MS Remote Sensing & GIS (2 years).

The roadmap has been designed under the guidelines of HEC and policy guidelines for master programs of BU. The roadmap and course contents has been discussed with the faculty members and academic

experts in DBOS. The DBOS meeting was held at Karachi Campus and with the faculty members of E&ES Islamabad Campus. The above said program was recommended by the DBOS.
The roadmap and course details are presented at appendage 2505 for approval /recommendation in the forthcoming FBOS.

Discussion

HoD E&E BUKC presented the agenda point which was deliberated in detail by the house. The house approved the agenda.

Decision 2508

The case to be forwarded for the approval in ACM.

Item 2509: Curriculum Redesign for BS(CS), BS(IT) and BS(AI) in Accordance with OBE	
Sponsor: HOD (CS) BUIC	Referral Authority: DBOS CS BUIC

Summary of the Case

1. A committee was formulated by Dean (ES) to re-design the curriculums of the computing programs (BSCS, BSIT, BSAI) in accordance with OBE.
2. The committee, with the support of subject experts, re-designed the curriculums of the three computing programs and identified program PEOs, CLOs for each course and the corresponding mappings.
3. Dr. Imran Siddiqi presented the salient features of the OBE system to the members.
4. The re-designed curriculum documents were shared with all members of the DBoS a week prior to the meeting.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the curriculum redesign attached at appendage 2506 . It was further decided that a detailed workshop on OBE will be conducted for the faculty members of the department. FMs will acquaint themselves with the new model in the Fall 2021 semester and provide their feedback to improve/revise the CLOs of the courses they are teaching as well as the corresponding mappings.

Decision 2509

The case to be forwarded for the approval in ACM.

Item 2510: Eligibility Criteria for Registering Final Year Project in BS (CS), BS(IT) and BS(AI) Programs	
Sponsor: HOD (CS) BUIC	Referral Authority: DBOS CS BUIC

Summary of the Case

The eligibility criterion for registering the FYP shall be clearance of at least 80 credit hours by the 6th semester. This criterion is not implemented in the system and the department needs to manually check this criterion for each student registering FYP.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house suggested that IT department should be asked to implement the criteria in the system. This will help in saving time and effort required to manually calculate the Credit hours completed by students.

Decision 2510

Case to be processed on file with DIT.

Item 2511: Roadmap Revision in BS(CS), BS(AI) and BS(IT) Programs	
Sponsor: HOD (CS) BUIC	Referral Authority: DBOS CS BUIC

Summary of the Case

1. A committee comprising of Dr. Arif Ur Rahman, Dr. Sumaira Kausar and Dr. Momina Moetesum was constituted to review the roadmaps of BS(CS), BS(AI) and BS(IT) programs and recommend changes, if necessary.
2. Following discrepancies in the current roadmaps were highlighted by the committee members:
   a. Some lab codes are inconsistent with the respective courses. For instance, Applied Physics lab, Robotics lab and Digital Image Processing lab, etc.

b. Some courses being offered at UG level have codes greater than 600 in UCC.
c. Due to their demand and importance, some courses should be included in the list of electives i.e. Software Testing and Software Quality Assurance.

Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the agenda point attached at appendage 2507.
Decision 2511
Point dropped.

Item 2512: Addition of BS (IT) Electives	
Sponsor: HOD (CS) BUKC	Referral Authority: DBOS CS BUKC

Summary of the Case
As per the directions of Dean ES, OBE based model has been implemented on Department of Computer Sciences. A thorough working has been conducted by the committee of CS FMs of all campuses.
The CLOs, PLOs etc are shared with the department. Once received, a detailed discussion on the CS BUKC DBoS has been carried out where some suggestion to improve the existing designed is proposed at appendage 2508.
Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house the house approved the agenda point. This agenda point is to be included in Agenda # 2509.
Decision 2512
Point dropped

Item 2513: MS (AI) new program launch	
Sponsor: HOD (CS) BUKC	Referral Authority: DBOS CS BUKC

Summary of the Case
Dean ES asked the suggestions of department to launch MS – AI program.
After the detailed analysis of admission trend of MS (CS), it has been observed that launching of new program i.e.., MS –AI will surely become the reason of reducing the existing MS (CS) program.
For Spring 2022, students are still less than 10 and phase two also does not seams to complete the minimum intake requirement of MS (CS) program.
There is not any considerable number of students who seams willing to have MS –AI program. Moreover, there are number of elective courses in existing roadmap where student easily get good expertise in AI field. is proposed at appendage 2509.
Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that launch of MS –AI is not recommended by house.
Decision 2513
Point dropped.

Item 2514: Revision of PEOs of Bachelor of Computer Engineering program	
Sponsor: HOD (CE) BUIC & BUKC	Referral Authority: DBOS CE BUIC & BUKC

Summary of the Case
- Pakistan Engineering Council (PEC) conducted a two-day accreditation visit to the Department of Computer Engineering at Bahria University (Karachi Campus) to evaluate the program of Bachelor of Computer Engineering on December 27-28, 2021.
- During the PEC visit, it was highlighted that PEOs of the Bachelor of Computer Engineering program need to be revisited.
- CE BUKC presented the agenda which were deliberated in 25th meeting of FBoS-ES in detail.
- Changes are presented by HoD CE BUKC are attached at appendage 2509.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the agenda point attached at appendage 2509.

Decision 2514

The case to be forwarded for the approval in ACM.

Item 2515: KPI Mapping for PEOs of CE department, Karachi Campus	
Sponsor: HOD (CE) BUKC	Referral Authority: DBOS CE BUKC

Summary of the Case

- PEC visit team reviewed the KPI mapping for PEOs of the Computer engineering department.
- During the PEC visit, it is highlighted that KPI mapping for PEOs consists of the keyword "Optional" in the threshold column (appendage 2510) should be removed to make the mapping threshold more significant.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that KPI mapping may be revised after detailed decision of PEC.

Decision 2515

Point dropped.

Item 2516: Revised Internship feedback Forms	
Sponsor: HOD (CE) BUKC	Referral Authority: DBOS CE BUKC

Summary of the Case

PEC visit team reviewed the Internship feedback form of the computer engineering department and added that there must be an option of marking "0" against any of the PLOs to make it more realistic for the internship supervisor not to mark against each of 12 PLOs which are not being assessed in internship duration.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the revised internship feedback forms attached at appendage 2511.

Decision 2516

Point dropped.

Item 2517: Introducing a New Engineering Elective Course "Blockchain Application Development"	
Sponsor: HOD (SE) BUKC	Referral Authority: DBOS SE BUKC

Summary of the Case

As part of the continuous curriculum development process, the Department of Software Engineering proposes to introduce a new course under the category of Engineering Electives, namely "Blockchain Application Development" as 2 (Theory) + 1 (Lab) = 3 Cr. Hrs. course. The introduction of this course is to cater the needs of recent advancements taking place is software development industries.

The course can be taught to students of 5th semester and onwards in the BSE program, and is recommended to have a pre-req of "Computer Programming (CSC 113)". In addition, such course can develop interests and needful knowledge/skills among students to consider FYPs related to this area of work. This point was also recommended by the Department's CAC members in the last, i.e. 10th CAC meeting.

A detailed course description along with books and proposed set of lab experiments is attached at appendage 2512.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed to further improve the course contents.

Decision 2517

Point dropped.

Item 2518: Introducing a Lab Component of existing Core Course "Software Quality Engineering"	
Sponsor: HOD (SE) BUKC	Referral Authority: DBOS SE BUKC

Summary of the Case

As part of the continuous curriculum development process, the Department of Software Engineering proposes to introduce a lab component in the existing core course, namely "Software Quality Engineering" which is offered in the 6th semester of the BSE roadmap.

Currently, the said course is of 3 + 0 = 3 Cr. Hrs. and the department proposes it to be converted into a 2 (Theory) + 1 (Lab) = 3 Cr. Hrs. course. The introduction of a lab component within this course is to cater the current practices in Software industries where automated software testing and quality check tools are being favored largely rather than manual testing approaches. This point was also recommended by the Department's CAC members in the last, i.e. 10th CAC meeting.

Details of the proposed set of lab experiments are attached at appendage 2513.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed to further improve the lab contents.

Decision 2518

Point dropped.

Item 2519: Change in total marks of final year project from 100 to 200 marks	
Sponsor: HOD (SE) BUKC	Referral Authority: DBOS SE BUKC

Summary of the Case

The Final Year Project (FYP) is divided in two courses, i.e. FYP-I and FYP-II, each of 3 credit hours. In the current practice, FYP is evaluated out of 100 marks where this total is distributed into two/three parts (e.g. 30 Marks for FYP-I and 70 Marks for FYP-II).

In CMS, the submitted results are mapped to out of 100 marks for FYP-I and FYP-II each. In case a result is submitted for FYP-I out of 30 Marks, then the result is up-scaled to out of 100 Marks. This eventually leads towards a change in grades. To avoid such an issue, the current practice is to reflect the total FYP marks gained by the student in both FYP-I & FYP-II. However, such practice leads into a transcript over which performance the student would be exactly the same in both FYP-I & FYP-II, which is far from reality and may also reflect suspicion when viewed by others.

Hence, it is recommended to adopt 200 Marking Scheme, i.e. 100 Marks for FYP-I and 100 Marks for FYP-II, to avoid all kind of hassles being currently faced.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that ESC 498 and ESC 499 course codes are to be mentioned in transcript. Also the house agreed that internship is to be added in transcript for EE BUKC.

Decision 2519

The case to be forwarded for the approval in ACM.

Item 2520: CQI Process for All courses and courses with > 20% (A or F grades)	
Sponsor: HOD (SE) BUKC	Referral Authority: DBOS SE BUKC

Summary of the Case

At the Department of Software Engineering, a CQI process is executed periodically for all courses at end of each semester at both CLOs and PLOs level. In the previous semesters (Fall 2019 – Spring 2021), several courses / students have been identified that required corrective actions.

Details of "CLOs CQI Process" are attached at appendage 2514.
Details of "PLOs CQI Process" are given are attached at appendage 2515.

Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the CQI cycle.
Decision 2520
Point dropped.

Item 2521: Vision & Mission of BSEAS.	
Sponsor: Dean (ES)	Referral Authority: Dean ES

Summary of the Case
Vision & Mission of Bahria School of Engineering & Applied Sciences (BSEAS) needs to be aligned with vision & mission of Bahria University.

Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed approved the following vision & mission:

Vision
To become a distinguished engineering and applied sciences school contributing towards strengthening knowledge-based economy while addressing local and global societal challenges.
Mission
To groom students by inculcating professional attributes of highest level in the domain of engineering and applied sciences and engender sensitivity towards moral and cultural values.
Decision 2521
The case to be forwarded for the approval in ACM.

Item 2522: Changes required in BCE Curriculum 2020.	
Sponsor: HOD (CE) BUIC	Referral Authority: DBOS CE BUIC

Summary of the Case
1. BCE 2020 roadmap was approved in 36th ACM. Following changes are required in the road map:
2. Management Science Electives present at Framework table and semester wise course offerings tables:
3. Mention of MS Elective I and MS Elective II in Framework as well as semester wise course offering tables.
3. Name of course; Data Communication & Networking to be replaced by Computer Communication & Networking in the Framework table
4. Cloud and Distributed Computing course is to be replace by Comp. Eng. Depth Elective I, and subsequent by Comp. Eng. Depth Electives II, III, and IV in the framework table
5. The title of Management Science Electives (MSE - I) and Management Science Electives (MSE - II) table in Elective courses list to be swapped
6. Following tables to be removed:
    a. Comparison of the Course Titles adopted for BCE Curriculum at Bahria University Vs The Course Titles Suggested by PEC table
    b. Course Titles adopted for BCE Curriculum at BU vs Course Titles Suggested by PEC table
    c. List of Courses with New Unified Course Codes and Proposed Course Codes are attached at appendage 2516.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the changes in the roadmap.

Decision 2522

The case to be forwarded for the approval in ACM.

Item 2523: Corrections in Roadmap of BCE Program.

Sponsor: HOD (CE) BUIC — Referral Authority: DBOS CE BUIC

Summary of the Case

BCE 2020 roadmap was approved in 36th ACM. Following typo mistake is identified:

For: Numerical Analysis 2+1=2
Read: Numerical Analysis2+1=3

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the correction due to typo mistake.

Decision 2523

The case to be forwarded for the approval in ACM.

Item 2524: Revision in BEE Depth Elective Courses

Sponsor: HOD (EE) BUKC — Referral Authority: DBOS EE BUKC

Summary of the Case

- Roadmap of BEE was revised in 32nd ACM in accordance with HEC guideline. The revision contains the change of Depth Elective-V credit hours in 8th Semester from 3+1 to 3+0. Further, list of depth elective courses was updated with the addition of new courses and change of credit hours in all streams.
- Few of Depth Elective Courses credit hours was set as 3+0 considering the non-availability of lab resources. However, new equipment & resources have been procured and available to conduct the lab. In this regard, following courses are proposed to change their credit hours to 3+1.

Telecom	Electronics	Power
1. Digital Image Processing 2. Telecom Transmission & Switching Systems	1. Digital Image Processing	1. Renewable Energy Systems 2. FACTS and HVDC

- Following new courses with 3+0 credit hours are proposed to add in the list of depth elective course to be offered. There are no prerequisites of the following courses.

Telecom	Electronics	Power
<u>None</u>	**<u>None</u>**	1. Distributed Generation Systems and its Grid Integration. 2. Power System Economics. 3. Optimization Methods in Modern Power Systems. 4. LV and HV Electrical Installation guides and Standards. 5. Energy Conservation and Auditing

- Some courses in the list are set as 3+1 but due to the non-availability of lab resources, the courses couldn't be offered. Therefore, following courses are proposed to be changed from 3+1 to 3+0 credits hours.

Telecom	Electronics	Power
1. Radar Systems. 2. RF & Microwave Engineering. 3. Multimedia Communication	1. Solid State Devices. 2. RF & Microwave Engineering. 3. Opto-Electronics.	None

- The new proposed courses outline of attached at appendage 2517.
- The updated depth elective course list for three streams is attached at appendage 2518.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that due to unavailability of lab equipment and staff, these courses cannot be added at the moment. HOD (EE) BUIC & BUKC may provide a detailed working in next FBoS.

Decision 2524

Point dropped.

Item 2525: Anomaly of Power Stream in BEE program at EE_BUKC

Sponsor: HOD (EE) BUKC Referral Authority: DBOS EE BUKC

Summary of the Case

• According to 30th & 34th ACM, "Power Systems" stream of BEE program was started w.e.f Fall 2017 Intake. However, the PEC has approved this stream with title "Power" stream.

• The issue arose when intake Fall 2017 graduated students found "Power Systems" stream instead of PEC approved title "Power" stream specialization on their transcripts which is in line with the 30th & 34th ACM decision.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that PEC has approved the proposed specialization stream as "Power". Therefore, the same correction should be made in the minutes of 30th & 34th ACM. The transcripts and degrees of Power stream students should also be issued accordingly.

Decision 2525

The case to be forwarded for the approval in ACM.

Item 2526: Inclusion of Supervisor marks in MS Thesis Evaluation

Sponsor: HOD (EE) BUKC Referral Authority: DBOS EE BUKC

Summary of the Case

• In PG Rule 2017 the MS thesis is evaluated by external & internal examiners and the marks awarded by examiners are averaged.

• It is a matter of concern that the supervisor is given no weightage in the evaluation marks. Although, he guides the student throughout the research period and has a better understanding of the student's efforts.

• The point discussed in DRC and then was taken to the FRC where it was suggested to check the policy of some other reputable universities in this regard.

• Following are the policy of some prestigious Pakistani universities:

i NUST: No marks are allocated for thesis, only grades are given to students. For defense, the student must publish one paper. The department forms a GEC (Guidance and Evaluation Committee), consisting of two members and a supervisor. The supervisor will be the chair of GEC. The GEC will evaluate the thesis and grade it.

ii NED University of Engineering and Technology: The thesis is given to those students who have completed the 12 credit hours with a CGPA of 2.75. The thesis is evaluated by the Examiner's Committee comprising of at least two examiners including the Supervisor. Examiner (other than the supervisor) may also be from outside the University. The Examiner's Committee shall examine and grade the Thesis: 'S' for satisfactory without any corrections or with corrections; otherwise 'U' for unsatisfactory.

iii Mehran University of Engineering and Technology: The thesis is given to those students whose GPA is 3.0 in the first two semesters. The supervisor shall propose a panel of external and internal experts for the conduct of the viva voce examination. The thesis is evaluated by an internal and external examiner. If the examiners recommend that the student is successful at the viva voce examination, he/she may be declared to have passed the master's degree examination.

iv Capital University of Science & Technology: Thesis shall be examined in an open defense by a thesis defense committee comprising of:
(a) Dean of the Faculty – Convener
(b) External examiner – Member
(c) Internal examiner – Member
(d) Supervisor – Member

After the defense, convener of the defense committee invites the recommendations of examiners as to:
(a) Thesis may be accepted.
(b) Thesis may be accepted after minor revisions.
(c) Thesis may be accepted after major revisions, or
(d) Thesis may be rejected.

Thesis are graded by the members of the defense committee as per the following weightage:
(a) External Examiner – 40%
(b) Internal Examiner – 30%
(c) Supervisor – 30%

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that the supervisor should also be a part of the thesis evaluation and thesis shall be graded by the members of the defense committee as per following weightage:
(a) External examiner marks weightage = 40%.
(b) Internal examine marks weightage = 40%
(c) Supervisor marks weightage = 20%

Decision 2526

The case to be forwarded for the approval in ACM.

Item 2527: Revision of Electrical Engineering PEOs	
Sponsor: HOD (EE) BUKC	Referral Authority: DBOS EE BUKC

Summary of the Case

• As per PEC visitation team observation during visit on 27th and 28th December 2021, the PEOs of electrical engineering department needs improvement. The PEVs have shown their concern in the evaluation report as:

"PEO Statement is not suitable/ repetition of PLOs. Few words "skillful employable graduates" in PEO 2 should be improved. PEO 1 and 2 are somehow overlapping. Minor wording correction in PEO 3 is suggested".

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that PEOs may be revised after detailed decision of PEC.

Decision 2527

Point dropped.

Item 2528: Allocation of FYP thesis report marks	
Sponsor: HOD (EE) BUKC	Referral Authority: DBOS EE BUKC

Summary of the Case
The FYP policy was approved in 23rd FBOS. According to which the marks distribution doesn't include the weightage of FYP thesis report. During the recent PEC visit the evaluators have shown concern about it.
Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house approved the revised marks distribution in FYP policy attached at appendage 2519.
Decision 2513
The case to be forwarded for the approval in ACM.

Item 2529: Redefining KPI for PLO	
Sponsor: HOD (EE) BUKC	Referral Authority: DBOS EE BUKC

Summary of the Case
i. The policy for clearing/passing of PLO in order to attain Graduate Status for Engineering Department mentioned in 21st FBoS – Item 2107:
In order to clear a PLO, 60% of CLOs related to that PLO should be cleared.
ii. On OBE portal the calculation of PLO-KPI use the number of CLO counts for percentage calculation.
iii. It was highlighted as the observation during the PEC visit that the KPI calculation for PLO, which in most cases is more than 90% need to be well defined in accordance with PEC guidelines mentioned in Manual of Accreditation 2019.
Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that all departments will do analysis of the PLOs. Also analysis of existing practices in different universities will also be done.
Decision 2529
Point dropped.

Item 2530: Extension in Time-bar as per relaxation given by PEC	
Sponsor: HOD (SE) BUIC	Referral Authority: DBOS SE BUIC

Summary of the Case
PEC gave relaxation to those students who were unable to complete their degrees beyond 7 Years of allowed time period vide letter no: PEC/EAD/40-GB/004/2021 dated May 21, 2021 attached at appendage 2520. PEC has allowed all such students to appear in exams/evaluations till 31-12-2023. Time-bar waiver cases were processed through file. One of the recommendation received from Director QA was to get 1 time approval of time-bar extension in the completion of degree programs in the ACM.
Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed that all such engineering students who were unable to complete their degrees within 7 years and can complete their degree requirements through examination/evaluation or completion of allied degree requirements (internships and CSP) by 31-12-2023 may kindly be allowed to complete their degree requirement.
Decision 2530
The case to be forwarded for the approval in ACM.

Item 2531: Lab Grading Policy	
Sponsor: Principal (SEAS) BUKC	Referral Authority: Principal (SEAS) BUKC

Summary of the Case
Dean (ES) made Lab Grading Policy Committee with Assoc. Dean (ES) as its chair. Committee presented the lab grading policy after due deliberation.
Discussion
Lab Grading Policy was thoroughly deliberated in 25th meeting of FBoS-ES and finalized lab grading policy is attached at appendage 2521.
Decision 2531
Point dropped.

Item 2532: Applicability of MS Allowance to FMs/Staff	
Sponsor: HOD (SE) BUIC	Referral Authority: DBOS SE BUIC

Summary of the Case
- BU has been giving MS/MPhil allowance to FMs/Staff either at the time of joining or once the junior faculty especially Lab Engineers improve their qualification. The same was approved in DHR letter dated 21 August, 2021 attached at appendage 2522.
- However, MS allowance was discontinued vide letter dated 2 Dec, 2021 and allowance was only approved for MPhil degree attached at appendage 2523.
- All postgraduate programs being offered in Engineering and Computing domain are offered as MS program. Same is the case with the Earth & Environmental sciences domain. MPhil programs are more specifically being offered in Applied Sciences domain like Mathematics, Physics and Chemistry and majority of the Humanities domain.
- The current policy is discouraging for the junior faculty of Engineering Sciences more specifically the Lab Engineers and is cause of disparity among the faculty. Being an academic institution itself, it is clear that there is no difference in MS & MPhil degree and BU has made no such distinction in the past. HEC also considers both the degrees equivalent (HEC letter attached at appendage 2524).

Discussion
The sponsor presented and iterated the case. After detailed discussion and arguments, the house agreed FMs/ & other members of Staff improving their degrees through MS program may be included for the MS/MPhil allowance as per previous practice for the uniform applicability of pay/allowances policy.
Decision 2532
The case to be forwarded for the approval in ACM.

Closing of the Meeting

There being no further points, the Chair brought the meeting to close, thanking the participants for their wholehearted participation in both sessions.

Prof. Dr Atif Raza Jafri
Dean (ES), Head FBoS
February, 2022

Distribution:

BUHQ:	Rector, Pro-Rector, Registrar DAA
BUIC:	DG BUIC, DIC HOD(EES), HOD(EE), HOD(CS), HOD(SE), HOD(CE)

BUKC:	DG BUKC, DKC HOD(EES), HOD(EE), HOD(CS), HOD(SE), HOD(CE)
BULC:	DLC, HOD(CS)

Appendages:

Appendage 2501

Item 2640: BBA Programme - Activity Based Assessment of the 'Oral Communication' Course	
Sponsor: HOD(MS)KC	Referral Authority: FBOS M&SS

Summary of the Case

301. 'Oral Communication' course formed part of the BBA curriculum. True to its name, any written assessment tool for this course would be unsuitable. The examination needed to assess the student's demonstrated ability to perform different tasks. To that end, an assessment format was proposed at Appendage 2640 (page 336) as part of the case working paper, for approval.

Discussion

302. HOD(MS)KC presented the working paper. BULC highlighted the importance of record keeping of oral activities. Dir Academics suggested facilities of the Media Studies department for recording the tests. It was clarified that the 40-mark activity-based format would be applied to the final exam only and that the mid-term exam would continue to be conceptual and written. It was also responded that the exam would take 4 hrs and that the MS Dept BUKC was ready to experiment the new format in the final exam of the current semester (Spring 2016). The aspect of misusing the 40% sessional marks came up and it was agreed that the teachers had to be trusted otherwise even written examinations could be manipulated. Besides, recording would keep a check on such tendencies. The Council approved the case for the MS Dept BUKC.

Decision 2640

303. The 40-mark 'Activity-based Assessment' format for the final examination of 'Oral Communication' course of BBA, comprising mock interviews, group presentations and participation, approved for MS(Dept)KC wef Spring 2016. Progress to be reported.

Action Required	Action by	Responsibility of
Implementation of the Decision	HOD(MS)KC	Dean M&SS
Statutory Documents affected: BBA Roadmap		

S.no	Title	Semester	Total Students	Percentage As or Fs
1.	Critical Thinking	7A,B,C,D	93	47% A
2.	Electrical Machines Lab	5A,B,C,D	95	44% A
3.	Electronic Devices and Circuits Lab	3A,B,C,D	140	44% A
4.	Embedded System Design Lab	5A,B,C,D	92	32% A
5.	Industrial Process Control Lab	7A,B,C,D	84	42% A
6.	Introduction to Computing Lab	1A,B,C,D	146	22% A
7.	Islamic Studies	1A,B,C,D	146	21% A
8.	Power Electronics Lab	7A,B,C	94	64% A

Spring 2021:

S.no	Title	Semester	Total Students	Percentage As or Fs
1.	Critical Thinking	4A,B,C,D	137	25% A
2.	Engineering Economics and Management	8A,B,C,D	94	42% A
3.	Engineering Ethics	8A,B,C,D	94	30% A
4.	Entrepreneurship	6A,B,C,D	96	23% A
5.	Introduction to Mechatronics Lab	8A,B,C,D	79	30% A
6.	Linear Circuit Analysis Lab	2A,B,C,D	139	43% A
7.	Linear Control Systems Lab	6A,B,C,D	87	29% A
8.	Power Electronics Lab	6A,B,C,D	89	35% A

CQI Cycle by Cluster Head (Electronics)

	Attainment percentage			
Courses	CLO1 %	CLO2 %	CLO3 %	CLO4 %
Fpga Based System Design – BEE 6A	91	48		65
Fpga Based System Design – BEE 6B	85	96		100
Fpga Based System Design – BEE 6C	86	57		89
Fpga Based System Design – BEE 6D	39	61		54
Avearge	75.25	65.5		77
Pakistan Studies – BEE 2A		0	86	
Pakistan Studies – BEE 2B		93	4	
Pakistan Studies – BEE 2C		0	13	
Pakistan Studies – BEE 2D		0	52	
Avearge		23.25	38.75	
Linear Control Systems Lab – BEE 6A	100	66		
Linear Control Systems Lab – BEE 6B	98	95		
Linear Control Systems Lab – BEE 6C	98	83		
Linear Control Systems Lab – BEE 6D	25	18		
Avearge	80.25	65.5		
Power Electronics – BEE 6A			25	
Power Electronics – BEE 6B			96	
Power Electronics – BEE 6C			96	
Power Electronics – BEE 6D			90	
Average			76.75	
Linear Control Systems – BEE 6A		86		
Linear Control Systems – BEE 6B		84		
Linear Control Systems – BEE 6		57		
Linear Control Systems – BEE 6D		94		
Average		80.25		

Cohort level Analysis Spring 2021

CQI Cycle by Cluster Head (Telecomm)

Table: Cohort level Analysis Spring 2021

Cohort	Attainment percentage			
Courses	CLO1 %	CLO2 %	CLO3 %	CLO4 %
Fpga Based System Design - BEE 6A	91	48	61	65
Fpga Based System Design - BEE 6B	85	96	69	100
Fpga Based System Design - BEE 6C	86	57	79	89
Fpga Based System Design - BEE 6D	39	61	68	54
Avearge	75.25	65.5	69.25	77
Differential Equations - BEE 2A	89	69	49	
Differential Equations - BEE 2B	86	71	37	
Differential Equations - BEE 2C	94	81	34	
Differential Equations - BEE 2D	82	62	56	
Avearge	87.75	70.75	44	
Linear Control Systems Lab - BEE 6A	100	66	100	
Linear Control Systems Lab - BEE 6B	98	95	82	
Linear Control Systems Lab - BEE 6C	98	83	100	
Linear Control Systems Lab - BEE 6D	25	18	94	
Avearge	80.25	65.5	94	
Linear Control Systems - BEE 6A	100	100	100	
Linear Control Systems - BEE 6B	93	84	74	
Linear Control Systems - BEE 6C	100	57	100	
Linear Control Systems - BEE 6D	89	94	94	
Average	95.5	83.75	92	

Appendage 2503

Course	Current Prerequisite (Telecommunication)	Current Prerequisite (Electronics)	ACM Approved/ACM Updated	Recommended Prerequisite
Industrial Process Control (EEN 441) (3+1)	NA	1) EEN 412 (Linear systems & Control) 22nd ACM 2) None 32nd ACM	22nd /32nd	Linear Control Systems
Industrial Automation (EEN 420)	NA	1) EEN 312 (Electrical Machines) 22nd ACM 2) EEN 219 (Electrical Machines 32nd ACM)	22nd /32nd	Electrical Machines with course code EEN 312

Course Code Correction of Electrical Machines

Course/Semester	Current Code 32nd ACM (Item 3223)	Code in 22nd ACM	Code in 30th ACM (Item 3008)
Electrical Machines (5th Semester)	EEN 312 (As course of 5th Semester) EEN 219 as Pre-req of Industrial Automation & Control (EEN 420, Electronics Elective) EEN 219 as Pre-req of Power Distribution & Utilization (EEN-433, Electronics Elective)	EEN 312	EEN 219

Appendage 2504

ROAD MAP
BS Remote Sensing & GIS

YEAR -1

Semester I

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	Lab		
1	PAK 102	Pakistan Studies	3	0	Civilization Course (1)	Existing BS ES
2	ISL 102/ SOC 360	Islamic Studies / Ethics	3	0	Civilization Course (2)	Existing BS ES
3	ENG103	English I	3	0	Expository Writing (1)	Existing BS ES
4	MAT 105*	Mathematics (for Pre-Med.)	0	0	Zero credit course	Existing BS ES
5	CSC 105 CSL 105	Introduction to Computers and Programming Introduction to Computers and Programming Lab	2	1	Quantitative Reasoning (1)	Existing BS ES
6	PHY 101 PHL 101	Physics Physics Lab	2	1	Natural Sciences (1)	Existing BS ES
7	GEO 105	Physical & General Geology	3	0	Major	Existing BS ES HEC roadmap NUST (IGIS) IST (NCRG)
	Total Credit Hours		**18**			
	Practical Learning Lab (2 contact hours)					

*Academic credit hour of this course is zero but its contact hours, teaching materials and tuition fee are equal to a 3 credit hour course.

Semester II

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	Lab		
1	ENG 104 *Pre req: ENG 103*	English II	3	0	Expository Writing (2)	Existing BS ES
2	PSY 107	Introduction to Psychology	3	0	Social Sciences (1)	Existing BS ES
3	MAT 115 *Pre-req: MAT 105*	Calculus & Analytic Geometry	3	0	Distribution (1)	Existing BS ES
4	MTB 411 MTL 411	Introduction to Film Making and Analysis Introduction to Film Making and Analysis Lab	2	1	Arts & Humanities (1)	Existing BS ES
5	RGS 104	Physical Geography	2	1	Major	HEC roadmap IST (NCRG)

	RGL 104	Physical Geography Lab				
6	RGS 106 RGL 106 *Pre-req: RGS 104*	Introduction to Remote Sensing Introduction to Remote Sensing Lab	2	1	Major	HEC roadmap NUST, IGIS IST (NCRG) Uni of Arizona, US Uni of Brighton, UK
	Total Credit Hours		**18**			
	Practical Learning Lab (3 contact hours)					

YEAR-2

Semester III

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	Lab		
1	HSS 320 *Pre req: ENG 104*	Technical Writing & Presentation Skills	3	0	Expository Writing (3)	Existing BS ES
2	CHM 105 CHL 105	Chemistry Chemistry Lab	2	1	Natural Science (2)	Existing BS ES
3	HSS 111	Introduction to International Relations	3	0	Social Sciences (2)	Existing BS ES
4	RGS 201 RGL 201 *Pre req: CSC 103*	Introduction to Cartography Introduction to Cartography Lab	2	1	Major	HEC roadmap IST (NCRG) Uni of Arizona, US
5	RGS 202 RGL 202 *Pre req: RGS 104*	GPS & Surveying GPS & Surveying Lab	2	1	Major	HEC roadmap IST (NCRG) Uni of Brighton NUST (IGIS)
6	RGS 203 RGL 203 *Pre req: RGS 104*	Fundamentals of GIS Fundamentals of GIS Lab	2	1	Major	HEC roadmap IST (NCRG) Uni of Arizona, US Uni of Brighton, UK
	Total Credit Hours		**18**			
	Practical learning Lab (4 contact hour)					

Semester IV

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	Lab		
1	MAT 205	Statistics	3	0	Quantitative Reasoning (2)	Existing BU Geosci.

2	GEO 223	Urban and Town Planning	3	0	Arts & Humanities (2)	Existing BS ES/Geo
3	RGS 204 RGL 204 *Pre-req: RGS 106*	Introduction to Photogrammetry Introduction to Photogrammetry Lab	2	1	Major	HEC roadmap Uni of Peshawar NUST (IGIS)
4	RGS 206 RGL 206 *Pre req: RGS 203*	Database Management Systems Database Management Systems Lab	2	1	Major	HEC roadmap BU BS AI NUST (IGIS)
5	RGS 207 *Pre req: RGS 106*	Active Remote Sensing & Space Laws	3	0	Major	Uni of Peshawar IST (NCRG)
6	RGL 251	Field Work and Report-I	1	2	Lab/Field Work	Similar to BS Geo/ES
	Total Credit Hours		**18**			
	Practical Learning Lab (4 contact Hours)					

YEAR-3

Semester V

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	**Lab**		
1	RGS 315	Human Geography	3	0	Major	HEC roadmap IST (NCRG) Uni of Peshawar Univ. of Brighton, UK
2	RGS 316 RGL 316 *Pre req: RGS 207*	Microwave & Hyper Spectral RS Microwave & Hyper Spectral RS Lab	2	1	Major	HEC roadmap IST (NCRG) Uni of Peshawar
3	RGS 317 *Pre req: RGS 206*	Spatial Decision Support Systems	3	0	Major	HEC roadmap IST (NCRG)
4	RGS 318 RGL 318 *Pre req: RGS 201 RGS 203*	Spatial Data Infrastructure & Visualization Spatial Data Infrastructure & Visualization Lab	2	1	Major	HEC roadmap Uni of Peshawar NUST (IGIS)
5	RGS 319 RGL 319 *Pre req:*	Multidisciplinary Applications of GIS & RS	2	1	Major	Uni of Peshawar Uni. of Brighton, UK NUST (IGIS)

	RGS 106 *RGS 203*	Multidisciplinary Applications of GIS & RS Lab				
6	RGS 320 *Pre req:* *RGS 106* *RGS 203*	Geospatial Project Management	3	0	Major	HEC roadmap IST (NCRG)
	Total Credit Hour		**18**			
	Practical Learning Lab (3 contact hours)					

Semester VI

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	Lab		
1	GEO 425	Research Methodology	3	0	Distribution (2)	Existing BS GeoSci. HEC, IST, UoP
2	RGS 330 RGL 330 *Pre req:* *CSC 103*	Web GIS Web GIS Lab	2	1	Major	Uni of Arizona, US NUST (IGIS)
3	RGS 331 RGL 331 *Pre-req:* *RGS 106*	Digital Image Processing Digital Image Processing Lab	2	1	Major	HEC roadmap Uni of Peshawar IST NCRG NUST
4	RGS 332 *Pre req:* *RGS 202*	Satellite Navigation Systems	3	0	Major	IST (NCRG) Pennsylvania University Norwegian University
5	RGL 351	Field Work and Report-II	1	2	Lab/Field Work	Similar to BS Geo/ES
	Total Credit Hours		**15**			
	Practical Learning Lab (4 contact hours)					

YEAR-4

Semester VII

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	Lab		
1	RGS 360 RGL 360 *Pre-req:* *RGS 318*	Spatial Data Analysis Spatial Data Analysis Lab	2	1	Major	HEC roadmap IST (NCRG) Uni of Peshawar NUST (IGIS)
2	RGS 361 RGL 361 *Pre-req:* *RGS 319*	Integrated Geospatial Technologies Integrated Geospatial Technologies Lab	2	1	Major	NUST (IGIS) Uni of Arizona, US

3	ENV 425	Occupational Health & Safety	3	0	Distribution (3)	Existing BS ES
4	GEO 326 GEL 326	Computing with MATLAB Computing with MATLAB, Lab	2	1	Distribution (4)	Existing BS GeoSci.
5		Elective I	2	1	Minor	List of electives
	Total Credit Hours		**15**			
	Practical Learning Lab (4 contact Hours)					

Semester VIII

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	**Lab**		
1	RGS 471	Legal and Social Issues in Geospatial Sciences	3	0	Major	IST (NCRG) Uni of Peshawar
2		Elective II	2	1	Minor	List of electives
3		Elective III	2	1	Minor	List of electives
4	RGS 490	Thesis	0	6	Thesis	HEC
	Total Credit Hours		**15**			
	Practical Learning lab (8 contact hours)					

List of Elective Courses

Sr. No.	Course code	Course Title	Credit Hours	Remarks
1	AIC 201 AIL 201	Artificial Intelligence Artificial Intelligence Lab	2 1	BS AI
2	AIC 301 AIL 301	Machine Learning Machine Learning	2 1	BS AI
3	AIC 303 AIL 303	Artificial Neural Network Artificial Neural Network Lab	2 1	BS AI
4	RGS 451 RGL 451	Computer Aided Drafting/Drawing Computer Aided Drafting/Drawing Lab	2 1	HEC/NUST (IGIS)
5	RGS 452 RGL 452	Data Structures and Algorithms Data Structures and Algorithms Lab	2 1	HEC/NUST/IST/BU AI
6	RGS 453	Environmental Geography	3	HEC/Uni of Peshawar
7	RGS 454 RGL 454	Spatial Data Modelling Spatial Data Modelling Lab	2 1	HEC roadmap
8	RGS 455 RGL 455	Land & Water Information System Land & Water Information System Lab	2 1	HEC/IST
9	RGS 456 RGL 456	GIS Programming & Python GIS Programming & Python Lab	2 1	HEC/NUST/ Penn State Uni.,

DETAILS OF COURSE CONTENTS

The courses contents of courses being offered in BS Geoscience and BS Environmental Sciences Program are followed as same in BS Remote Sensing & GIS.

MAJOR COURSES

RGS 104 Physical Geography (3 Credit Hours)

Course Outline:
Scope and status of physical Geography, The basic concept and theories in physical Geography, Factors of Landform Development, Desert Landforms, Glaciers and their topographic effects, Karsts topography, Type of soil, Factors and elements of weather and climate, Composition and structure of atmosphere, Horizontal and vertical distribution of temperature, The distribution of pressure and seasonal variations, Wind Circulation, Humidity and forms of condensation, Classification of Climate, Characteristic features of the oceans, Temperature, salinity distribution, cause and effects, Ocean circulation: Waves, currents and tides, their nature, causes and effects and impact on man and environment.
Lab Outline:
Study and identification of landforms using air photos and General topographic sheet, Use and making of various models showing various types of landforms, Recording and observation of weather data from a mini weather station, Identification of cloud types, Drawing of World map showing continents and oceans using Google Earth.

Reference Books/Material:
1. Strahler, A.N. (2004) “Modern Physical Geography” New York: John Wiley.
2. Gabler, R.E, Sager, R.J and Wise, D.L (2012). Essentials of Physical Geography, Latest Edition. Saunders College Publishing, New York. ISBN 0-03-098237-5.
3. Scott, R.C (1996) Introduction to physical geography, West Publishing Co, New york. ISBN: 0-314-06260-2.

GEO 105 Physical & General Geology (3 Credit Hours)

Course Outline:
Overview of Earth, Geological Framework of Earth, Structure and Composition of Earth; Deformation and Mountain Building Processes, Rock Cycle Volcanoes, Identification of rocks and minerals in hand specimen, Identification of different rock units and geological structures in field, Geological Hazards; Earthquakes, Tsunamis, Floods, Landslides, Mass-movements, Geological Time Scale; Cenozoic, Mesozoic, Paleozoic, Fossils and Evolution, Global Change in the Earth System, Economic Geology; Exploration and Exploitation of Natural Resources, Petroleum Basins of Pakistan. Field visit to different nearby rocky area.

Reference Books/Material:
1. McGeary, D., Plummer, C.C. & Carlson, D.H., (2004) Physical Geology: Earth revealed. McGraw Hill, Boston.
2. Murphy, B and Nance D (1999). Earth Science Today. ITP, Brooks Cole Publishing, NYC. ISBN 0-534-52182-7.
3. Dutch, S.I; Monroe, J.S and Moran, J.M (1998). Earth Science, Wadsworth, ISBN: 0 314 20111

RGS 106 Introduction to Remote Sensing (3 Credit Hours)

Course Outline:

Definition and History of satellite Remote sensing, Remote sensing and earth energy budget, Electromagnetic spectrum and radiation, Physical foundation of Visible, Infrared and microwaves remote sensing, high and low resolution remote sensing, Theoretical explanation of reflection, absorption and transmission, High resolution multi-spectral data, Introduction to Aerial Photograph, Sensor Systems, Platforms (Types and Orbital Characteristics),Thermal Infrared (Characteristics, TIR Band Properties, TIR Image Interpretation, Intro to Microwave (Importance and applications), Digital Image Processing (Overview of computer based image processing), Applications (agriculture, urban, natural resources etc.)

Lab Outline:

Introduction to labs, Single band image interpretation, False color predictions, False color composite Images Interpretation, Visual Interpretation of aerial photographs, Various sensors data comparison, Thermal Infrared Image interpretation, Intro to ERDAS Imagine, display, Geo-linking, Zooming, Identification of target features.

Reference Books/Material:

1. Sabins S.F (2000). Remote Sensing: Principles and Interpretation, Third Edition. Freeman and Company, New York. ISBN: 0 – 7167-2442-1.
2. Lillesand, T. M. and Kiefer, R. W. (2004). Remote Sensing and Image Interpretation, 5th edition. (John Wiley and Sons), ISBN 0-471-15227-7
3. Jensen, J. (2000) Remote Sensing of the Environment: An Earth Resources Perspective, Amazon Publishers

RGS 201 Introduction to Cartography (3 Credit Hours)

Course Outline:

Introduction to Cartography, Nature of Cartography, Map Types. History of Cartography, Map Symbols, Lettering, Scale and direction, Coordinate systems, Map Projections Graphical and datum, Map Projections Mathematical. Perspective, non-perspective, conventional, Generalization, Thematic Maps, Descriptive Statistics, Class Intervals, Choropleth Maps, Proportional Symbol Maps, Dot Maps, Isarithmic Maps, Cartograms, Flow Maps, Graduate Colour Maps, Map Compilation, Map Design, Map Production Software.

Lab Outline:

Map reading, Assignment on Types of Maps symbology, Development of Symbol Charts, Development of Graphical Map Projections, Large to small scale map conversion, Data classification and Thematic Mapping, Map composite development, Misleading cartography.

Reference Books/Material:

1. Slocum, Robert McMaster, Fritz Kessler, Hugh Howard (2004) Thematic Cartography and Geographic Visualization, 2nd Edition, Terry. ISBN, 0130351237.
2. Robert G. Cromley (2003) “Digital Cartography”. Prentice Hall Inc.
3. M.J. Kraak & F.J. Ormeling, (1996) “Cartography- Visualization of Spatial Data.” Addison Wesley Longman Limited.
4. Robinson, A.H., Morrison,J.L., Muhrcke, A.J.,Kimerling and Guptil,S.C. (1995) “Elements of Cartography” 6th edition, John Wiley & Sons, New York.

RGS 202 GPS & Surveying (3 Credit Hours)

Course Outline:

Introduction to GPS, GPS Data, Position and Time from GPS, Pseudo-Range Navigation, Receiver Position, Velocity, and Time, Carrier Phase Tracking (Surveying), GPS Satellite Signals, GPS Error Sources, GPS survey procedure, Differential GPS Techniques. Overview of surveying, objects and classifications of surveying, scales, survey tasks, survey principles and methods, accuracy and precision, measurement and errors, coordinate systems and computation, direct distance measurements, errors in measurement of distance and corrections, height measures, leveling and its types, bench marks, leveling staff, sources of errors in leveling and accuracies, angular measurements, reading systems of optical theodolites, indirect distance measurements, reciprocal leveling, traverse survey, triangulation and trilateration,

Lab Outline:

GPS value reading, Easting Northing & elevation, Map Projections and Datum Settings, GPS based surveys, tracking and data processing, Planimetric & vertical errors calculations, Instrumental surveys will be included for measuring the distance, angles and heights. Major emphasis will be towards theodolite and leveling surveys.

Reference Material:

1. Anderson, J. M., Mikhail E. M., (1998), Surveying Theory and Practice, 7th Ed., MCB/McGraw-Hill, US, ISBN 0-07-015914-9
2. Wolf P R., Ghilani C, (2005), Elementary Surveying : An Introduction to Geomatics ,11th Edition, Prentice Hall, USA, ISBN 0131481894
3. Wirshing R., Wirshing R. J., (1985), Schaum's Outline of Introductory Surveying, McGraw-Hill, UK, ISBN 0070711240
4. Michael Kennedy (2002), "The Global Positioning System and GIS: An Introduction" 2nd Edition, Taylor & Francis, New York. ISBN: 0 – 415-28608-5
5. Paul Zarchan (1996), "Global Positioning System: Theory and Application, Volume I, American Institute of Aeronautics and Austronautics, Inc., Washington DC. ISBN: 1563471078

RGS 203 Fundamentals of GIS (3 Credit Hours)

Course Outline:

Introduction, Definitions, Key components of GIS, Functional Subsystem, Raster Data Model, Vector Data Model, Attribute Data Model, Data Acquisition Techniques, Data sources, Data capturing techniques and procedures, Data Transformation, Visualization of spatial data, Layers and Projections, Map Design: Symbols to Portray Points , Lines and Volumes , Graphic Variables , Visual Hierarchy, Data Classification Graphic Approach , Mathematical Approach, Spatial Analysis: Overlay Analysis ,Spatial analysis, Neighborhood functions, Network and overlay analysis, buffering, Spatial data Quality: Components of Data Quality , Micro Level Components , Macro Level Components , Usage Components Sources of Error, Accuracy, Project work.

Lab Outline:

Introduction to GIS Lab (hardware / software), Raster/Vector/Attribute Data Display, Scanning, Digitization, Coordinate based point mapping, Raster / Vector Conversion, Digitization of Map features, Data layer integration and display of different projections, Map layout, Data Classification and Thematic Mapping, Handling with Topological Errors, Overlay and network analysis.

Reference Books/Material:

1. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Fifth Edition. ISBN - 0912804008
2. Clarke, K. (2004) "Getting started with Geographic Information System", Prentice Hall , New York, Second Edition. ISBN – 1879102897
3. McDonald, R. and Burrough, P. (2001) "Principles of Geographic Information Systems", Oxford University Press, Oxford, Second Edition ISBN - 0198233855

RGS 204 Introduction to Photogrammetry (3 Credit Hours)

Course Outline:
Introduction, history and Overview, Analog, analytical, and digital photogrammetry, Photogrammetric cameras, Sensor, films and filters, Data acquisition methods. Single photograph properties, Spatial measurement and scale calculation, Problems with aerial photograph and rectification of a single aerial photograph, Aerial Photograph Interpretation, Types of Aerial Photograph and mosaics, Stereoscopic Analysis DEM generation, Orthophotography/Orthoimage, applications.

Lab Outline:
Comparison of formats, Area and scale measurement, Parallax and radial displacement, Visual interpretation of aerial photographs, vertical airphotos, Mirror stereoscopic interpretation, Ortho-rectification, case studies**.**

Reference Material:
1. Sabins S.F (2000). Remote Sensing: Principles and Interpretation, Third Edition. Freeman and Company, New York. ISBN: 0 – 7167-2442-1.
2. Lo, C.P (1986). Applied Remote Sensing (Longman).
3. Philipson, W.R (1997) Manual of Photographic Interpretation (2nd edition) (American Society for Photogrammetry and Remote Sensing).
4. Colwell, R.N (ed.) (1983) Manual of Remote Sensing Second Edition in 2 volumes (American Society of Photogrammetry)

RGS 206 Database Management Systems (3 Credit Hours)

Course Outline:
Basic database concepts; Entity Relationship modeling, Relational data model and algebra, Structured Query language; RDBMS; Database design, functional dependencies and normal forms; Transaction processing and optimization concepts; concurrency control and recovery techniques; Database recovery techniques; Database security and authorization, Database normalization process techniques, Query optimization (Relational Algebra), Small Group Project implementing a database. Concepts of database securities, Development of a GUI interface.

Lab outline:
Structured Query language commands, PL/SQL Commands, Creating & populating tables, Design of simple database, Indexing concepts, Performance of concurrency protocols, Partial & full recovery techniques,. Design and implementation of a simple MIS system.

Reference Books/Material:
1. Date, C.J. (2004) Database Systems, Addison Wesley Pub. Co. ISBN - 0201385902
2. Connolly R. and P.Begg (2003) Database Systems: A Practical Approach to Design, Implementation and Management, Addison-Wesley Pub. Co ISBN – 0321210255
3. Elmasri, R. and Navathe, S.B (2004) "Fundamentals of Database Systems" Addison-Wesley Pub. Co ISBN – 0-201760355
4. Rigaux, P. Scholl, M. and Voisard, A.(2001) "Spatial Databases: With Application to GIS" Morgan Kaufmann; 2nd edition ISBN – 01017386802

RGS 207 Active Remote Sensing & Space Laws (3 Credit Hours)

Course Outline
Introduction to Active Remote Sensing Types of Active Remote Sensing. Advantages and Disadvantages of Active Remote sensing, Sensor and Platform (Space and airborne, MSS, TM, ETM, HRV, LISS, IKONOS-2, Quick bird-2, AVHRR and others), working Mechanism, Spectral Characteristics of

multispectral images, Basic Concepts, Image Geometry, Data Compression and Reconstruction, Image Pre-processing and Classification, Field Verification, Data Fusion Techniques. Space Laws, History, International Space Agency, SUPARCO, Satellite Launching; Mechanism, Space Ethics. Applications of Active Remote Sensing and Space Laws.

Lab Outline:

Introduction to Image Processing of Active Sensors, Multispectral Image comparisons, Visual Interpretation of Images, Image pre-processing, Student Projects.

Reference Material:

1. Campbell, James B. (2002) "Introduction to Remote Sensing", 3rd Ed., The Guilford Press ISBN # 0-7484-0663-8 (pbk).
2. Henderson, F.M and Lewis, A.J (Latest edition), "Principles and Applications of Imaging Radar".

RGS 315 Human Geography (3 Credit Hours)

Course Outline

Scope and Status of human Geography, Basic concepts and theories including Environmental determinism, Possibilism, Probabilism and cognitive behaviorism, Population: Population distribution, density and growth. Population change including migration, Population composition and Structure, Human Activities: Primary, secondary and Tertiary (agriculture, mining, forestry animal husbandry, poultry, light and heavy industries, transport and trade and tourism) and their impacts on environment, Natural resources, distribution and utilization: Renewable and non-renewable resources e.g., Air, land, water, fauna and flora fossil fuel metallic and non-metallic minerals, Energy generation and consumption, Human Settlements: Evolution and housing types, Urban and Rural contrast, Land Use/land cover Pattern e.g. Commercial, Industrial and Residential, Open and Green Spaces, Transport, Theories of urban structure e.g., Concentric Zone Theory, Multiple Nuclei Theory, Sector Theory, Rural Settlements, Dispersed, Nucleated and Ribbon Settlements, City-Size, Distribution, Rank-Size Rule, Primate Cities.

Reference Books/Material:

1. Knox, P.L. & S.A. Marston (2003) "Places and Regions in Global Context: Human Geography" Prentice Hall. (3rd Edition)
2. Becker, A. & Secker (2002) "Human Geography: Culture, Society, and Space" John Wiley and Sons. (7th Edition)
3. Blij, H.J.D. (2002) "Human Geography: Culture, Society, and Space" John Wiley and Sons (7th Edition)

RGS 316 Microwave & Hyper Spectral RS (3 Credit Hours)

Course Outline:

Introduction of new and advanced developments that are taking place especially in microwave and hyper spectral remote sensing. Basic concepts, Types of sensors, History, Advantages and Disadvantages of Active Remote sensing; data acquisition, working mechanism, Spectral and spatial characteristics of microwave and hyper spectral images (RADAR, SRTM, SAR, AIRSAR, SLAR etc.); RADAR Image Geometry and interferometry, Data Compression and Reconstruction, RADAR Image Pre-processing and Classification, Field Verification, Data Fusion Techniques, Microwave Applications, Hyperspectral Remote Sensing Channels and Spectral Libraries Sensors (AIS, AIVIS etc.); Applications of Radar and hyper spectral datasets, Image Interpretation.

Lab Outline:

Introduction to Microwave Image Processing Module, Microwave Image Comparisons, Visual Interpretation of Radar Images, Radar Image pre-processing (Total Power Image, Like and Unlike

Polarization, Ground Resolution, Rectification and Registration, Optical and RADAR data fusion case studies.

Reference Books/Material:

1. Campbell, James B. (2002) Introduction to Remote Sensing. 3rd Ed., The Guilford Press.
2. Henderson, F.M and Lewis, A.J (1998) Principles and Applications of Imaging Radar. Manual of Remote Sensing. 3rdEd. Vol. 2. John Wiley and Sons, New York..
3. Peebles, P.Z (1998) Radar Principles. Wiley Inter science, New York.
4. Elachi, C. (1988) Space-borne Radar Remote Sensing: Applications and Techniques. IEEE Press, New York.

RGS 317 Spatial Decision Support Systems (3 Credit Hours)

Course Outline:

Decision Making Processes (Introduction, Major decision-making Paradigms, Models of decision-making, Different types of problem, Hierarchy of decisions); Methods and techniques to support spatial decisions; Performance modelling and types of criteria, Measurement Scales, Uncertainty in decision making process Decision Support Systems (Introduction, Origin, Definition and components, Fundamental Phases, Characteristics and Capabilities of DSS); GIS and Decision Support Systems, Integration of GIS and DSS Multicriteria Evaluation (Criteria properties, Criteria weighting, Pair wise comparison, Ranking techniques, Rating techniques, Sensitivity analysis, Redistribution criteria weight, Option Ranking methods, Weighted summation, Ideal point, Rank order); Methods and Tools for Collaborative Decision- Making; Consensus Evaluation; Conflict Analysis.

Reference Books/Material:

1. A . E. Turban and J. Aronson (1998), Decision Support Systems and Intelligent Systems, 5th edition, Prentice Hall. ISBN: 0-13-781674-8
2. B .Sauter, V. (1997) “Decision Support Systems ”, John Wiley & sons, HEC — RS&GIS Curricula 2005 29 Inc. ISBN: 0-471-31134-0

RGS 318 Spatial Data Infrastructure & Visualization (3 Credit Hours)

Course Outline:

Need and main components of Spatial Data Infrastructure (SDI), Metadata concepts, its structures and functionality, System Architecture for SDI Interoperability; Client Server Architecture, Data Quality Information (DQI) Accuracy, Precision, Bias Error Modeling, Problems of information sharing (Heterogeneities), Distributed database concept, SDI Technologies; Legal aspects of SDI.

Introduction to spatial data visualization, Visualization Process, Visualization Strategies, Statistical and Visual Foundation, Principles of Symbolization, Principles of Colour, Tri-Simulate(chromatic Model, Intensity, Hue and Saturation, Map Design Process, Mapping Techniques; Map Animation, Virtual Reality, Electronic Atlases and Multimedia.

Lab Outline:

Comparison of working SDI’s, Development of Metadata according to Standards, Development of Architecture of SDI, Data Standardization, Data transformations and translations, Data Modeling Abstraction of real world, Types of abstraction, 3D Modelling

Reference Books/Material:

1. Robert, C. H. (2005) “ SDI : A View from Europe” Oxford University Press, Oxford, ISBN: 089875982X.
2. Groot, R. (2001). Geospatial Data Infrastructure: Concepts, Cases, and Good Practice (Spatial Information Systems (Cloth)), Oxford University Press.

3. Beth E. Lachman (2001). Lessons for the Global Spatial Data Infrastructure: International Case Study Analysis, RAND Corporation.
4. Mapping Science Committee (1993), " Toward a Coordinated Spatial Data Infrastructure for the Nation,".National Academy Press.

RGS 319 Multidisciplinary Application of GIS & RS (3 Credit Hours)

Course Outline:

Introduction to the scope of both GIS and satellite remote sensing in modern era, identification of trending applications for mapping and modelling of natural hazards/disasters (urban floods, earthquakes, tsunami, land sliding etc.) water related issues, environmental issues, administrative and managerial issues, land cover/ land uses, developmental projects, watershed management, urban planning, rural areas planning etc.

Related lab work considering scope of course, interest of students, data and software resource availability.

Reference Books/Material:

1. Lillesand, T. M. and Kiefer, R. W. (2004), "Remote Sensing and Image Interpretation", 5th ed., (John Wiley and Sons), ISBN 0-471-15227-7
2. Mather, P M (2004), "Computer Processing of Remotely Sensed Images", 3rd Ed., (John Wiley and Sons), ISBN 0-470-84919-3
3. Campbell, James B. (2002), "Introduction to Remote Sensing", 3rd Ed., The Guilford Press, ISBN # 0-7484-0663-8 (pbk).

RGS 320 Geospatial Project Management (3 Credit Hours)

Course Outline:

Overview, project management, project organization, projection selection models and techniques, Cost Benefit analysis, Project planning, project scheduling, project monitoring, reporting and controlling, and project termination.

Reference Books/Material:

1. Merideth, J.R., Sammuel, J. Manbel. (1989) Project Management, New York, John Wiley. ISBN: 0471-85319-4
2. Choudhry, S. Taha, (2000) Project Management, India, McGraw Hill.ISBN: 0-13-032374-8
3. LittleI. M.D., Mirrlees, J.M. (1982) Project Appraisal and Planning for Developing Countries, India, Oxford and IBH. ISBN: 0-435-84501-2

RGS 330 Web GIS (3 Credit Hours)

Course Outline:

Basic concepts and theory of interactive platform, as the combination of web and GIS (Geographic Information Systems). Introduction to the expanding scope of web and mobile-based mapping applications of GIS. Cloud GIS. Introduction to Google Earth Engine. Development procedures of Web GIS applications to e-government, e-business, e-science, and daily life, public services etc. Online maps and geospatial intelligence using various spatial data layers as web layers and maps.

Lab Outline:

Build interactive web based GIS app that use geospatial data in an attractive format. Create a map tour application using ArcGIS Online. Create web apps with ArcGIS Web AppBuilder or HTML, ArcJava Script.

Reference Books/Material:

1. **Pinde Fu, 2015, Getting to Know Web GIS.** ESRI Press. Redlands, CA. ISBN-13: 978-1589483842 ISBN-10: 1589483847.
2. **Pinde Fu, and Jiulin Sun.** 2010. *Web GIS: Principles and Applications*. ESRI Press. Redlands, CA. ISBN 158948245X (Available at Amazon

RGS 331 Digital Image Processing (3 Credit Hours)

Course Outline:

Data Sources and Procurement, Data Formats (BSQ, BIL, BIP, etc.) Theory of Image Processing Techniques; Image Subsetting & Enhancement, Image Cleaning, Atmosphere Path Correction,, Image Mosiacing and Color Balancing, Image Rectification, Registration and Re-sampling, Band Ratios, Vegetation Indices, Image Filtering, Difference Images, Principal Component Analysis, Classification Schemes, Types, Algorithms, Field data collection, Qualitative and quantitative techniques, sampling techniques, Error matrices, Ground-Verification (Field Verification). Demonstration of image processing software.

Lab Outline:

Intro to lab and software, Image Management (Import/Export & Display), Enhancement Techniques, Spectral and spatial digitizing (image masking), Mosaicing and color balancing, Rectification and Registration and Re-sampling, Band Ratio, Vegetation Indices, Difference images, Image filters, Signature selection, Supervised, Unsupervised and Hybrid classification, ISODATA, MDM, MLC, and Baysian classification, Error Matrix Generation, Classification validation, field work. Project work will be based on data sets obtained from resource monitoring agencies such as SUPARCO).

Reference Books/Material:

1. Gibson, P.J and Power, C.H (2000). Introductory Remote Sensing: Digital Image Processing and Applications. Routledge. ISBN 0-415-18962-4
2. Sonka, M; Hlavac, V and Boyle, R (1999). Image Processing, Analysis and Machine Vision (2nd Edition) International Thompson Publishing (ITP) Company. ISBN 0-534-95393-X
3. Jensen, J. R. (2002), Digital Image Processing: A Remote Sensing Perspective, Prentice Hall, New York.

RGS 332 Satellite Navigation Systems (3 Credit Hours)

Course Outline:

Fundamental framework and applications of modern global navigation satellite systems (GNSS) and inertial navigation systems (INS). Need and evolution of GPS Modernization as Global Navigation Satellite System (GNSS). The course gives an overview of satellite based radio navigation systems such as: GPS, GLONASS, GALILEO and BEIDOU, the basics of receiver design, wave propagation in the atmosphere; Geodesy, the geodetic fundamentals of navigation e.g., positioning, reference- and coordinate systems and computational methods for navigation and positioning on the surface of the earth.

Reference Books/Material:

1. Van Sickle, Jan (2015) *GPS for Land Surveyors*, *4th Ed.* CRC Press. (ISBN: 978-1-4665-8310-8)
2. Kaplan, E.D., Hegarthy C.J.: Understanding GPS/GNSS, Principles and Applications, 3rd Edition (ISBN: 978-1630810580).
3. McCormac J. C., McCourmac J. C., Anderson W., (1999), Surveying, 4th Edition, Wiley, UK, ISBN 0471366579

RGS 360 Spatial Data Analysis (3 Credit Hours)

Course Outline:
Introduction to spatial data type, Potentials of spatial data, Spatial Analysis, Point pattern analysis, Lines and networks, Area objects and spatial autocorrelation, types of area objects, Geometric properties of areas, Boundary Analysis, Buffering and neighbourhood function, Proximity Analysis, Neighbourhood Function/Analysis, Modelling and storing field data, Spatial interpolation, type, Methods / algorithms, Derived measures on surfaces, Map overlay, Vector and raster overlay operations, Problems in simple Boolean polygon overlay, Multivariate data, multidimensional space, Multivariate data and multidimensional space, Distance, difference and similarity, Cluster analysis, PCA, New approaches to spatial analysis, Interpolation techniques, surface modelling, DTM/DEM, Multi-criteria and Multi-attribute Modelling, Uncertainties in spatial modelling. Spatial data interpretation.
Lab Outline:
Assignment on Spatial Analysis for various applications, Geo-coding and Point analysis exercise, Network analysis, Areal analysis exercise, Buffer analysis exercise, Multivariate analysis, Assignment on advanced spatial analysis, Interpolation of elevation data and surface modeling, Suitability analysis, Risk Modeling, Assignment on uncertainties in spatial modelling.

Reference Books/Material:
1. Chang, Krang-tsung (2002) “Introduction to Geographic Information Systems” McGraw Hill. ISBN: 0-07-049552-1
2. David O’ Sullivan and David J. Unwin (2003) “Geographic Information Analysis”, John Wiley & Sons, Inc., Canada. ISBN: 0-471-2117-1
3. David L. Verbyla (2002) “Practical GIS Analysis”, , Taylor & Francis, London
4. John Stillwell & Graham Clarke (2004) “Applied GIS and Spatial Analysis”, John Wiley & Sons, UK. ISBN: 1-57504-101-4

RGS 361 Integrated Geospatial Technologies (3 Credit Hours)

Course Outline:
Use of geospatial techniques and methods (database designs, field surveys, GIS, GPS, satellite remote sensing images of active and passive sensors, programming algorithms) to design and development geospatial products and applications.
Lab Outline:
Introduction to any GIS software (QGIS, ArcGIS, Geometica etc.) which can handle integrated datasets and perform meaningful data integration. Generate integrated data products for further analysis, interpretation and application.

Reference Books/Material:
1. Lillesand, T. M. and Kiefer, R. W. (2004), “Remote Sensing and Image Interpretation”, 5th ed., John Wiley and Sons, ISBN 0-471-15227-7.
2. Gibson, P.J and Power, C.H (2000). Introductory Remote Sensing: Digital Image Processing and Applications. Routledge. ISBN 0-415-18962-4

RGS 471 Legal and Social Issues in Geospatial Sciences (3 Credit Hours)

Course Outline:
Introduction to the course, standardization of spatial objects, ethical issues, spatial areas, legal aspects of data, use data from other organizations, legal issues in vector data and raster data, reporting and controlling etc. Map ethics (making, production, publishing); Social and ethical issues in cartography, data modelling and spatial data visualization etc.

Reference Books/Material:

1. Sammuel, J. (2009), "Legal issues in GIS", London, John Wiley.
2. Lillesand, T. M. and Kiefer, R. W. (2004), "Remote Sensing and Image Interpretation", 5th ed., John Wiley and Sons, ISBN 0-471-15227-7.

RGL 251 Field Work & Report-I (3 Credit Hours)

One-week field work, demonstration of field instruments; Basic mapping procedures; Identification of feature, rocks, terrains and coastal features & resources etc.

RGL 351 Field Work & Report-II (3 Credit Hours)

One-week fieldwork for mapping of various terrains and their structures, coastal environment & morphological features by using integrated GIS/RS Techniques with other datasets.

RGS 490 Thesis (6 Credit Hours)

Students will be required to conduct research work during Final Year Project/Thesis work considering their keen interest in any subdomain of Remote Sensing or GIS.

Minor / Elective Courses

-------- Artificial Intelligence (3 Credit Hours)

Course Outline:

An Introduction to Artificial Intelligence and its applications towards Knowledge Based Systems; Introduction to Reasoning and Knowledge Representation, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, Alpha beta pruning, Game-playing); Case Studies: General Problem Solver; Recent trends in AI and applications of AI algorithms; Basic architecture of neural networks.

Reference Books/Materials:

1. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 3rd ed, Prentice Hall, Inc., 2015.
2. Norvig, P., "Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp", Morgan Kaufman Publishers, Inc., 1992.
3. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2009.

-------- Machine Learning (3 Credit Hours)

Course Outline:

Introduction to machine learning; concept learning: General-to-specific ordering of hypotheses, Version spaces Algorithm, Candidate elimination algorithm; Supervised Learning: decision trees, Naive Bayes, Artificial Neural Networks, Support Vector Machines, Overfitting, noisy data, and pruning, Measuring Classifier Accuracy; Linear and Logistic regression; Unsupervised Learning: Hierarchical Algomerative Clustering. k-means partitional clustering; Self-Organizing Maps (SOM) k-Nearest-neighbor algorithm; Semi-supervised learning with EM using labeled and unlabled data; Reinforcement Learning: Hidden Markov models, Monte Carlo inference Exploration vs. Exploitation Trade-off, Markov Decision Processes; Ensemble Learning: Using committees of multiple hypotheses, bagging, boosting.

Reference Books/Materials:

1. Machine Learning, Tom, M., McGraw Hill, 1997.
2. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012

-------- Data Mining and Neural Networking (3 Credit Hours)

Course Outline

Introduction to data mining and basic concepts, Association Rule mining using Apriori Algorithm and Frequent Pattern Trees, Introduction to Classification Types, Supervised Classification (Decision trees, Naïve Bae Classification, K-Nearest Neighbors, Support Vector Machines etc.), Unsupervised Classification (K Means, K Median, Hieratical and Divisive Clustering, Kohonan Self Organizing maps), outlier & anomaly detection, Web and Social Network Mining, Data Mining Trends and Research Frontiers. Fundamentals of Neural Networking, Case Studies of Neural Networking, Implementing concepts using software.

Reference Books/ Materials:

1. Jiawei Han & Micheline Kamber, Jian Pei (2011). Data Mining: Concepts and Techniques, 3rd Edition.
2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar (2005). Introduction to Data Mining.
3. Charu C. Aggarwal (2015). Data Mining: The Textbook
4. D. Hand, H. Mannila, P. Smyth (2001). Principles of Data Mining. MIT Press

RGS 451 Computer Aided Drafting/Drawing (3 Credit Hours)

Course Outline:

Introduction to engineering drawing/map, concept of lines, polgons, orthographic projection, projection of points, projection of lines, solids of revolution, introduction to Auto CAD map, drawing of 2D figure, drawing views of 3D Solids, Topology and Errors,.

Lab Outline:

Introduction to CAD Environment, Concept of reference systems, unit systems, points, reference plane, Drawing Lines, poly lines, 2nd order curves, polygons, cross-sectional areas, solid of revolution, shading, textures, rendering, etc.

Reference Books/Material:

1. Sham Tickoo, Auto CAD 2004: A Problem Solving Approach
2. David Frey, AutoCAD 2005 and AutoCAD LT 2005: No Experience Required

RGS 452 Data Structures and Algorithms (3 Credit Hours)

Course Outline:

Introduction to data structures and Algorithms and their inter linkage; Efficient storage of ADTs (Abstract Data Types) and memory intensive problems. Advantages and disadvantages of different data structures using Arrays, Stacks, Queues, Priority Queues and Linked Lists. Recursion, sorting and searching algorithms, Hashing, Binary tree algorithim, Storage and retrieval performance of different techniques

using various data structures. Introduction to theory of NP-Completeness and problem transformation.

Lab outline:

Implementing ADTs using arrays, dynamic memory, Implementation of stacks, Queues & priority Queues, linked lists (single, double, circular), tree searching algorithms, hash algorithms, performance of different data structure techniques, bubble sort and insertion sort for random and ordered data sets. Implementation and comparison of linear search and binary search.

Reference Books/Material:

1. Frank M. Carrano, Paul Helman, Robert Veroff, Data Abstraction and Problem Solving with C++, 2nd ed, Addison-Wesley, 1998
2. Lafore, Data Structures and Algorithms (SAMS teach yourself), Sams Publishing, 1999
3. Horowitz, Sahni, and Mehta Fundamentals of Data Structures in C++, Computer Science Press, 1995

RGS 453 Environmental Geography (3 Credit Hours)

Course Outline:

Meaning, scope, nature, importance and basic concepts. Resources and its management: human resources, water as a resource, soil as a resource, forest resources, land and agricultural resources, minerals & rocks resources, energy resources. Environmental processes: types, Causes, Effects, Consequences and remedies of Fluvial Processes, Glacial and Peri-glacial Processes, Mass Movements, Wind Action, Marine Processes, Endogenetic Processes, Desertification. Eco-System: Terrestrial, Aquatic, biosphere and Atmospheric Ecosystem. Emerging Environmental problems: Land Degradation, Atmospheric Pollution, Water Pollution. Environmental appraisal, legislations, institutions and management.

Reference Books/Material:

1. Marsh, W.M. &Grosha, J. (2005), "Environmental Geography: Science, land use and earth system", John Wiley and sons. Hoboken.
2. Bell, M. & Walker, M.J.C. (1992), "Late Quaternary Environmental Change: Physical and Human Perspectives". Longman Group. U.K.
3. Brimicombe, A. (2003), "GIS, Environmental Modeling and Engineering", Taylor and Francis.

RGS 454 Spatial Data Modelling (3 Credit Hours)

Course Outline:

Introduction to Fields, Objects, Geometry, Objects represented in raster, Vector Structure, Vector data representing the geometry of geographical objects, Networks and graphs, Properties of Graphs, graph areas and error checking procedures, Terrain object classed and generalization hierarchies aggregation hierarchies, object association, Fuzzy set theory, fuzzy boundaries, Uncertainties of Spatial Objects.

Lab Outline:

Preparation of Symbolic Charts for representation of Earth Features, Assignment on Geometry of spatial objects, Utility Network Analysis, Spatial data generalization and aggregation.

Reference Books/Material:

1. Michael, N. D.(2003) " Fundamentals of Geographic Information Systems" Third Edition, John Wiley & sons.
2. Heywood, I., Cornelius, S. and Carver, S. (1999) " An introduction to Geographic Information System", Addison Wesley Longman, New York, second edition.

3. DeMers, M. (1996) “Fundamentals of Geographic Information Systems”, John Wiley & Sons, New York.

RGS 455 Land & Water Information System (3 Credit Hours)

Course Outline:

Introduction to course, Displaying geographic data, Structure of spatial data in ILWIS, Displaying maps and Layer management, about domains, coordinates, representation and table, Attribute data, pixel information, spatial data input, spatial data management, Attribute data handling, Image processing, spatial and non-spatial data imports, Spatial data analysis, retrieval, classification and measurement operations, Spatial data analysis, overlay operations, spatial data analysis, neighbourhood and connectivity operations, Using digital Elevation Models, Geostatistical tools (Probabilities), Presentation of results.

Reference Books/Material:

1. ITC (2008) .“ILWIS Application Guide”, International Institute for Aerospace Survey and Sciences, Netherland.
2. Aronoff, S. (2005). “Remote Sensing for GIS Managers”. ESRI Press, New York.

RGS 456 GIS Programming & Python (3 Credit Hours)

Course Outline:

Intro to course; fundamentals of geodatabase processing; fundamentals of Python; using variables; naming conventions and reserved words; testing and printing variable values, Looping and control structures, Debugging, optional and required parameters, Objects, properties and methods; the OO paradigm; Object Model Diagrams, The geo-processor object, introduction, Functions and parameters, passing and returning values, Multiple inputs and complex parameter passing, Selections and sets, SQL basics.

Advanced programming topics such as creating multiprocessing applications, using version control software, Python package management and code distribution, the design and implementation of graphical user interfaces, solving of complex geoprocessing tasks on both proprietary and open source GIS platforms in Python.

Lab outline:

Introduction to Lab, Looping statements, Getting and setting object parameters, Exploring the geo-processor object, Arcpy and object-oriented programming exercises/ projects.

Reference Books/Material:

1. Ralston, B. A. (2002), Developing GIS Solutions with Map Objects and Visual Basic, On word Press, New York. ISBN: 0766854388
2. Kropla, B. (2005) “MapServer: Open Source GIS Development” Apress, Co. ISBN: 1590594908
3. Rigaux, P. Scholl, M. and Voisard, A. (2001) “Spatial Databases: With Application to GIS” Morgan Kaufmann; 2nd edition.ISBN: 1558605886.

Appendage 2505

ROAD MAP
MS Remote Sensing & GIS

YEAR -1

Semester I

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC/BU Policy	Remarks
			Theory	Lab		
1	RGS 504 RGL 504	Advanced Remote Sensing and Image Processing Advanced Remote Sensing and Image Processing Lab	2	1	Compulsory Course	HEC roadmap NUST IGIS
2	RGS 505 RGL 505	Advanced GIS Advanced GIS Lab	2	1	Compulsory Course	HEC roadmap Existing MS ES
3	RGS 506 RGL 506	Advanced Geo-database and Programming Advanced Geo-database and Programming Lab	2	1	Compulsory Course	HEC roadmap
4	ESC 701	Research Methodology	3	0	Compulsory Course	Existing MS ES
	Total Credit Hours		**12**			
	Practical Learning Lab (3 contact hours)					

Semester II

Sr. No	Course code	Course Title	Credit Hours		Category as per HEC Policy	Remarks
			Theory	Lab		
1		Elective-I	2	1		
2		Elective-II	2	1		
3		Elective-III	2	1		
4		Elective-IV	2	1		
	Total Credit Hours		**12**			
	Practical Learning Lab (4 contact hours)					

YEAR-2

Semester III

Sr. No	Course code	Course Title	Credit Hours	Category as per HEC Policy	Remarks
1	RGS-600	Thesis	3		

Semester IV

Sr. No	Course code	Course Title	Credit Hours	Category as per HEC Policy	Remarks
1	RGS-600	Thesis	3		

List of Elective Courses

Sr. No.	Course Code	Course Title	Credit Hours	Remarks
1	RGS 551 RGL 551	Advanced Computer Aided Drafting / Drawing	2 1	HEC/NUST (IGIS)

		Advanced Computer Aided Drafting / Drawing Lab		
2	RGS 552 RGL 552	Advanced Web GIS Advanced Web GIS Lab	2 1	HEC/NUST (IGIS)
3	RGS 553 RGL 553	Advanced Photogrammetry Advanced Photogrammetry Lab	2 1	Uni. of Pesh.
4	RGS 554 RGL 554	GIS for Coastal Zone Management GIS for Coastal Zone Management Lab	2 1	HEC roadmap
5	RGS 555 RGL 555	Land Use Planning and Management Land Use Planning and Management Lab	2 1	HEC roadmap
6	RGS 556 RGL 556	Advanced Digital Image Processing Advanced Digital Image Processing Lab	2 1	NUST (IGIS)
7	RGS 557 RGL 557	Advanced Integrated Geospatial Technologies Advanced Integrated Geospatial Technologies Lab	2 1	HEC roadmap
		Any elective course may be from ▪ HEC Raodmap ▪ MS Environmental Sciences ▪ MS Geophysics		

Course Details

RGS 504 Advanced Remote Sensing and Digital Image Processing (3 Credit Hours)

Course Outline:
In depth understanding of satellite remote sensing operation, image processing, analysis and interpretation. empirically based image transformations, filtering of images, discrete fourier transformations, principal components analysis, and spatial modeling, advanced image classifications such as fuzzy classifications, neural classifiers, spatial and spectral segmentation, sub pixel classification. SAR interferometry, applications of SAR interferometry, image spectrometry, Feature Extraction from Hyperspectral data, Image Residuals, Spectral Fingerprints, Absorption-band Parameters, Spectral Derivative Ratio, Classification Algorithms for Hyperspectral Data, radar remote sensing, speckle noise and suppression, texture analysis, data Fusion, DEM extraction from stereo SAR.

Lab Outlines:
Intro to ERDAS Imagine or any other software, used for lab exercises of above course content. Single band image, Multispectral image interpretation, Various sensors data comparison, Thermal Infrared Image interpretation, Enhancement Techniques, Spectral and spatial digitizing (image masking), Mosaicing and color balancing, Rectification and Registration and Re-sampling, Identification of target

features, various features extraction. Data classification, Thematic Mapping, Optical and RADAR data fusion case studies

Books Recommended:

1. Mather, P (2004). Computer processing of remotely sensed images. Third Edition, J Wiley. ISBN 0-470-849193.
2. David A Landgrebe (2003) Signal Theory Methods in Multispectral Remote Sensing (Wiley Series in Remote Sensing and Image Processing) Wiley-Interscience; Bk&CD-Rom edition ISBN: 047142028X.
3. Campbell, James B. (2002. Introduction to Remote Sensing, 3rd Ed., (The Guilford Press) ISBN # 0-7484-0663-8 (pbk).
4. Henderson, F.M and Lewis, A.J (1998). Principles and applications of Imaging Radar. Manual of Remote Sensing, Third Edition Volume 2. John Wiley and Sons. ISBN 0-471029406-3.
5. Roger M. McCoy (2004) Field Methods in Remote Sensing The Guilford Press ISBN: 1593850794
6. Walter G. Egan, Walter Egan (2003) Optical Remote Sensing: Science and Technology (Optical Engineering) Marcel Dekker ISBN: 0824741315
7. Fawwaz T. Ulaby (1986), Microwave Remote Sensing: Active and Passive, Volume I: Fundamentals and Radiometry (March, Artech House Publishers ISBN: 0890061904

RGS 504 Advanced Geographical Information System (3 Credit Hours)

Course Outline:

Basic Theory and Principles of Geographic Information Systems, Co-ordinate System and Map Projection, Drawing of Map Projections and Error Estimations, Understanding of Cartographic Errors and Rectification Procedures, Cleaning and Editing Cartographic Data Visualization of Geospatial Data, Symbolization and Map Layouts Development, 3D Visualization of Spatial Data, Alternate Approaches for Mapping (Geocoding, Survey Data Integration), Geocoding and Survey Data Integration in GIS, Point Pattern Analysis, Lines and Networks, Performing Network Analysis, Area Objects and Spatial Autocorrelation, Describing and Analyzing Fields, Spatial Interpolations, Geostatistical Analysis, Map Overlay Analysis, Multivariate Data, Multidimensional Space and Spatialization, GIS Modeling and Related Issues.

Lab Outline:

Introduction to GIS Lab (hardware / software), Raster/Vector/Attribute Data Display, Digitization, Coordinate based point mapping, Raster / Vector Conversion, Digitization of Map features, Data layer integration, Map layout, Assignment on advanced spatial analysis, Interpolation of elevation data and surface modeling, Suitability analysis, Risk Modeling, Assignment on uncertainties in spatial modelling.

Books Recommended:

1. John Stillwell (2004) Applied GIS and Spatial Analysis John Wiley & Sons, Ltd. England ISBN: 0470844094.
2. Aronoff, S. (2004) "Geographic Information Systems: A Management Perspective", WDL Publications, Ottawa, Fifth Edition. ISBN - 0912804008
3. Burrough, P.(2002) “Principles of Geographic Information Systems for Land Resources Management”, Oxford University Press, Oxford, Second Edition. ISBN - 0198233655
4. McDonald, R. and Burrough, P. (2001) “Principles of Geographic Information Systems”, Oxford University Press, Oxford, Second Edition ISBN - 0198233855
5. Jacek Malczewski (1999) GIS and Multicriteria Decision Analysis John Wiley & Sons, Inc. ISBN: 0471329444.

RGS 505 Advanced Geo-database and Programming (3 Credit Hours)

Course Outline:

fundamentals of geo-processing; fundamentals of Python; using variables; Database and Geodatabase, Integration of Data into Geodatabase Topology, Subtypes and Attribute Domains, Relationship Classes and Geometric Networks, UML and CASE Tools for Geodatabase, Overview of Visual Basic, Understanding Map Objects, Maps and Layers Controls, Coordinates and Map Projections, Geometrics, Map Display and Features Rendering, Data Access and Control, Address Matching, Application Deployment, Web GIS concepts, Cartography.

Lab outline:

Scope of GIs based Lab works and software applications, Looping statements, Getting and setting object parameters, Link ArcGIS and Python based programming applications; Exploring the geo-processor object, geomorphological features clipping exercises, raster statistics exercise, students projects

Books Recommended:

1. Ralston, B. A. (2002), Developing GIS Solutions with MapObjects and Visual Basic, Onword Press, New York. ISBN: 0766854388
2. Kropla, B. (2005) "MapServer: Open Source GIS Development" Apress, Co. ISBN: 1590594908
3. Rigaux, P. Scholl, M. and Voisard, A.(2001) "Spatial Databases: With Application to GIS" Morgan Kaufmann; 2nd edition.ISBN: 1558605886.
4. Kang-Tsung Chang Programming (2005) ArcObjects with VBA: A Task-Oriented Approach, CRC Press LLC. ISBN: 0849327814
5. Philippe Rigaux, et al (2002) Spatial Databases: With Application to GIS (Morgan Kaufmann Series in Data Management Systems) Academic Press, U.S
6. Menno-Jan Kraak (2001) Web Cartography, Taylor & Francis ISBN: 074840869X

ELECTIVE COURSES

RGS 551 Computer Aided Drafting (3 Credit Hours)

Course Outline:

Introduction to engineering drawing/map, concept of lines, polgons, orthographic projection, projection of points, projection of lines, solids of revolution, introduction to Auto CAD map, drawing of 2D figure, drawing views of 3D Solids, Topology and Errors,.

Lab Outline:

Introduction to CAD Environment, Concept of reference systems, unit systems, points, reference plane, Drawing Lines, poly lines, 2nd order curves, polygons, cross-sectional areas, solid of revolution, shading, textures, rendering, etc.

Books Recommended:

1. Sham Tickoo, Auto CAD 2004: A Problem Solving Approach
2. David Frey, AutoCAD 2005 and AutoCAD LT 2005: No Experience Required

RGS 552 Web GIS (3 Credit Hours)

Course Outline:

Basic concepts and theory of interactive platform such as Google Earth Engine, as the combination of web and GIS (Geographic Information Systems). Introduction to the expanding scope of web and mobile-based mapping applications of GIS. Cloud GIS. Introduction to Google Earth Engine. Development procedures of Web GIS applications to e-government, e-business, e-science, and daily life, public services etc. Online maps and geospatial intelligence using various spatial data layers as web layers and maps.

Lab Outline:

Build interactive web based GIS app that use geospatial data in an attractive format. Create a map using using ArcGIS Online or GEE. Create web apps with ArcGIS Web AppBuilder or HTML, ArcJava Script.

Books Recommended:

1. Pinde Fu, 2015, Getting to Know Web GIS. ESRI Press. Redlands, CA. ISBN-10: 1589483847.
2. Pinde Fu, and Jiulin Sun. 2010. *Web GIS: Principles and Applications*. ESRI Press. Redlands, CA. ISBN 158948245X (Available at Amazon
3. Lillesand, T. M. and Kiefer, R. W. (2004). Remote Sensing and Image Interpretation, 5th edition. (John Wiley and Sons), ISBN 0-471-15227-7

RGS 553 Advanced Photogrammetry (3 Credit Hours)

Course Outline:

Introduction to course, Analog and digital photogrammetry; Types of Aerial Photographs and mosaics Photogrammetric cameras; Review of data acquisition and single photograph properties; Spatial measurement and scale calculation; Aerial Photograph Interpretation; Stereoscopic Analysis DEM generation, Orthophotography/ Orthoimage, Drone Photogrammetry, Creation of geospatial products such as orthophotos and topographic mapsapplications.

Lab Outline:

Comparison of formats, Sensor, films and filters, Data acquisition methods, Area and scale measurement, Visual interpretation of aerial photographs, vertical airphotos, problems with aerial photograph and rectification of a single aerial photograph, exercises of Drone Photogrammetry, case studies.

Books Recommended:

1. Sabins S.F (2000) Remote Sensing: Principles and Interpretation. Third Edition. Freeman New York.
2. Lo, C.P (latest version) Applied Remote Sensing. Longman, London.
3. Philipson, W.R (1997) Manual of Photographic Interpretation. 2nd ed., American Society for Photogrammetry and Remote Sensing.
4. Colwell, R.N (ed.), (Latest version) Manual of Remote Sensing. 2nd Ed., 2 vol., American Society of Photogrammetry

RGS 554 GIS for Coastal Zone Management (3 Credit Hours)

Course Outline:

Introduction and scope of marine GIS, Introduction to Marine Regions, Water Resources, Spatial Formation and Distribution of Oceans, Characteristics of Oceans, Marine datasets Monitoring of Ocean Pollution using RS and GIS, Tools and Technologies for coastal resources mapping and modelling, Traditional Ecological Knowledge and Coastal GIS. Marine Spatial Planning Challenge, Applications and Case Studies.

Reference Books/Material:

1. Darius Bartlett, Jennifer Smith (2019). GIS for Coastal Zone Management. CRC Press

2. Robin K H Falconer " Experience with Geographic Information System (GIS) in the marine world". Hydrographic Journal
3. R G Humphreys A. R. I. C. S., Dip. H. S. "Marine Information System" the Hydrographic Journal
4. Kurt Fedra & Endrico Fedli" GIS technology and special analysis in Coastal Zone Management" by. EEZ Technology Edition 3.

RGS 555 Advanced Integrated Geospatial Technologies (3 Credit Hours)

Course Outline:
In depth understanding about application of geospatial data sets for various projects, Projects organization planning and management, such as urban project planning, Application of satellite image processing techniques, Accuracy testing between different data sets, Use of geospatial techniques and methods (database designs, field surveys, GIS, GPS, satellite remote sensing images of active and passive sensors, programming algorithms) to design and development geospatial products and applications.
Lab Outline:
Introduction to any GIS software (QGIS, ArcGIS, ERDAS, GEE, Arcpy etc.) which can handle integrated datasets and perform meaningful data integration. Generate integrated data products for further analysis, interpretation and application.

Reference Books/Material:
1. Lillesand, T. M. and Kiefer, R. W. (2004), "Remote Sensing and Image Interpretation", 5th ed., John Wiley and Sons, ISBN 0-471-15227-7.
2. Gibson, P.J and Power, C.H (2000). Introductory Remote Sensing: Digital Image Processing and Applications. Routledge. ISBN 0-415-18962-4

Appendage 2506

BS Computer Science

CURRICULUM DOCUMENT
DEPARTMENT OF COMPUTER SCIENCE, BAHRIA UNIVERSITY

Contents

Vision and Mission

Vision and Mission of Bahria University

Vision: To become a knowledge and creativity driven international university that contributes towards development of society.

Mission: To ensure academic excellence through deliverance of quality education and applied research in a collegiate environment having strong linkages with industry and international community to meet the societal challenges.

Vision of the Computer Science Department

To become a center of excellence in Computer Science education, research, and globalized technologies

Mission of the BS Computer Science Program

To produce graduates having good problem solving skills and knowledge to use computers creatively and effectively along with team building and professional skills.

Program Educational Objectives (PEOs)

PEO 1: Apply computing knowledge and skills to design and develop effective solutions for complex real-life problems.

PEO 2: Demonstrate ethical and moral conduct in professional practices.

PEO 3: Manifest life-long learning and inter-personal skills for sustainable career development and professional growth.

Program Learning Outcomes (PLOs)

PLO1 Academic Education: To prepare graduates as computing professionals.

PLO2 Knowledge for Solving Computing Problems: Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the 16 abstraction and conceptualization of computing models from defined problems and requirements.

PLO3 Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

PLO4 Design/ Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO5 Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

PLO6 Individual and Teamwork: Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

PLO7 Communication: Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

PLO8 Computing Professionalism and Society: Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

PLO9 Ethics: Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.

PLO10 Life-long Learning: Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Mapping of PLOs to PEOs

No.	Program Learning Outcomes (PLOs)	PEOs		
		PEO-1	PEO-2	PEO-3
1	Academic Education	✔	✔	
2	Knowledge for solving Computing Problems	✔		
3	Problem Analysis	✔		
4	Design/ Development of Solutions	✔		✔
5	Modern Tool Usage	✔	✔	
6	Individual and Teamwork		✔	✔
7	Communication			✔
8	Computing Professionalism and Society		✔	✔
9	Ethics		✔	
10	Life-long Learning			✔

Program Approval/Revision History

S No.	Description/Remarks	Approved by	Date
1.	Program Approval	4th ACM	5-11-2003
2.	Program Launch		
3.	Curriculum Revision	22nd ACM	Apr. 2014
4.	Curriculum Revision	26th ACM	Apr. 2016
5.	Curriculum Revision	31st ACM	Apr. 2018

Program Eligibility Criteria

Minimum 50% marks in Intermediate (HSSC) Examination (Pre-Medical/Pre-Engg.) or equivalent qualification with Mathematics certified by IBCC.

List of Courses
Computing Core Courses (39 credit hours)

Pre-requisite	Course Code	Course Title	Lec	Lab	CR
None	CSC 113	Computer Programming	3	1	4
CSC 113	CSC 210	Object Oriented Programming	3	1	4
CSC 113	CSC 221	Data Structure & Algorithms	3	1	4
None	GSC 221	Discrete Mathematics	3	0	3
CSC 221	CSC 320	Operating Systems	3	1	4
None	CSC 220	Database Management Systems	3	1	4
None	SEN 220	Software Engineering	3	0	3
None	CEN 222	Data communication and Networking	3	1	4
CEN 222	CSC 407	Information Security	3	0	3
None	ESC 498/499	Final Year Project	0	6	6

General Education Courses (19 credit hours)

Prerequisite	Course Code	Course Title	Lec	Lab	CR
None	ENG 105	Functional English	3	0	3
HSS 120	HSS 320	Technical writing and presentation skills	3	0	3
ENG 105	HSS 120	Communication Skills	3	0	3
None	CSC 307	Professional Practices	3	0	3
None	CSC 114	Introduction to Information & Communication Technology	2	1	3
None	PAK 101	Pakistan Studies	2	0	2
None	ISL 101	Islamic Studies	2	0	2

Mathematics and Science Foundation Courses (12 credit hours)

Prerequisite	Course Code	Course Title	Lec	Lab	CR
None	GSC 110	Applied Calculus & Analytical Geometry	3	0	3
None	GSC 122	Probability & Statistics	3	0	3
None	GSC 121	Linear Algebra	3	0	3
None	GSC 114	Applied Physics	2	1	3

University Electives (12 credit hours)

Prerequisite	Course Code	Course Title	Lec	Lab	CR
Foreign Language Related					
None	HSS 459	Foreign Language	3	0	3
Management Related					
None	MGT 111	Principles of Management	3	0	3
None	MKT 110	Principles of Marketing	3	0	3
None	MGT 242	Organizational Theory & Behavior	3	0	3
None	FIN 201	Fundamentals of Finance	3	0	3
Social Science Related					
None	HSS 107	Introduction to Psychology	3	0	3
None	HSS 202	Introduction to Sociology	3	0	3
None	HSS 115	Introduction to Media Studies	3	0	3
None	BES 103	Critical Thinking	3	0	3
Economy Related					
None	ACC 101	Principles of accounting	3	0	3
None	ECO 110	Microeconomics – I	3	0	3
None	HSS 411	Engineering economics and management	3	0	3
None	ECO 520	Economics	3	0	3
None	HSS 410	Entrepreneurship	3	0	3

Computer Science Core Courses (24 credit hours)

Prerequisite	Course Code	Course Title	Lec	Lab	CR
CSC 315	CSC 323	Compiler Construction	2	1	3
CEN 120	CEN 325/324	Computer Organization and Assembly Language	3	1	4
GSC 114	CEN 120	Digital Logic Design	3	1	4
CSC 221	CSC 321	Design and Analysis of Algorithms	3	0	3
CSC 320	CEN 455	Parallel & Distributed Computing	3	0	3
CSC 210	CSC 325	Artificial Intelligence	3	1	4
None	CSC 315	Theory of Automata	3	0	3

Computer Science Support Courses (09 credit hours)

Prerequisite	Course Code	Course Title	Lec	Lab	CR
GSC 110	GSC 210	Differential Equations	3	0	3
GSC 110	GSC 211	Multivariable Calculus	3	0	3
GSC 210	GSC 320	Numerical Analysis	3	0	3

List of Computer Science Elective Courses (18 credit hours)

Prerequisite	Course Code	Course Title	Lec	Lab	CR
CSC 220	CSC 468	Advanced Databases	2	0	2
CSC 220	CSL 468	Advanced Databases Lab	0	1	1
CSC 321	CSC 521	Advanced Design and Analysis of Algorithm	3	0	3
CSC 220	CSC 488	Big Data Analytics	2	0	2
CSC 220	CSL 488	Big Data Analytics Lab	0	1	1
CSC 210	CSC 459	Client Server Programming	2	0	2
CSC 210	CSL 459	Client Server Programming Lab	0	1	1
CSC 210	CSC 444	Computer Graphics	2	0	2
CSC 210	CSL 444	Computer Graphics Lab	0	1	1
SEN 310	CSC 484	Content Management	2	0	2
SEN 310	CSL 484	Content Management Lab	0	1	1
CEN 222	CEN 451	Data Encryption and Security	3	0	3
CSC 220	CSC 452	Data Mining	3	0	3
CSC 220	CSC 454	Data Warehousing	3	0	3

CSC 210	CEN 444	Digital Image Processing	2	0	2
CSC 210	CEL 444	Digital Image Processing Lab	0	1	1
EEN 313	EEN 325	Digital Signal Processing	2	0	2
EEN 313	EEL 325	Digital Signal Processing Lab	0	1	1
CSC 313	CSC 319	Game Development and Design	2	0	2
CSC 313	CSL 319	Game Development and Design Lab	0	1	1
CSC 221	CSC 486	Geographical Information System	2	0	2
CSC 221	CSL 486	Geographical Information System Lab	0	1	1
SEN 220	SEN 320	Human Computer Interaction	3	0	3
SEN 220	SEN 320	Human Computer Interaction	2	0	2
SEN 220	SEL 320	Human Computer Interaction Lab	0	1	1
CSC 325	CSC 466	Introduction to Biometrics	2	0	2
CSC 325	CSL 466	Introduction to Biometrics Lab	0	1	1
CSC 220	CSC 342	Introduction to Cloud Computing	3	0	3
CSC 220	CSC 487	Introduction to Data Science	2	0	2
CSC 220	CSL 487	Introduction to Data Science Lab	0	1	1
CSC 325	SEN 455	Knowledge Based Management System	3	0	3
SEN 213	CSC 458	Management Information System	3	0	3
CEN 120	CEN 320	Microprocessor & Interfacing	2	0	2
CEN 120	CEL 320	Microprocessor & Interfacing Lab	0	1	1
CSC 210	CSC 341	Mobile Application Development	2	0	2
CSC 210	CSL 341	Mobile Application Development Lab	1	0	1
None	SEN 493	Multimedia Systems	2	0	2
None	SEL 493	Multimedia Systems Lab	0	1	1
CSC 411	CSC 441	Natural Language Processing	3	0	3
CSC 325	CSC 449	Neural Networks & Fuzzy Logic	3	0	3
None	GSC 445	Operation Research	3	0	3
CSC 320	CEN 453	Real Time System	3	0	3
CSC 325	CEN 458	Robotics	2	0	2
CSC 325	CEL 458	Robotics Lab	0	1	1
SEN 310	SEN 422	Semantic Computing	3	0	3
SEN 310	SEN 421	Semantic Web	3	0	3
GSC 210	EEN 314	Signals and Systems	2	0	2
GSC 210	EEL 314	Signals and Systems Lab	0	1	1
GSC 121	CEN 450	Simulation and Modeling	2	0	2
GSC 121	CEL 450	Simulation and Modeling Lab	0	1	1
CSC 210	SEN 448	Software Application for Mobile Device	2	0	2

CSC 210	SEL 448	Software Application for Mobile Device Lab	0	1	1

SEN 220	SEN 457	Software Design and Architecture	2	0	2
SEN 220	SEL 457	Software Design and Architecture Lab	0	1	1
SEN 220	SEN 458	Software Requirement Engineering	3	0	3
CSC 323	CSC 451	Theory of Programming Languages	3	0	3
SEN 320	SEN 456	Usability Engineering	3	0	3
CEN 222	CSC 489	Ubiquitous Computing	3	0	3
CSC 210	CSC 313	Visual Programming	2	0	2
CSC 210	CSL 313	Visual Programming Lab	0	1	1
CSC 113	SEN 310	Web Engineering	2	0	2
CSC 113	SEL 310	Web Engineering Lab	0	1	1
SEN 220	SEN 410	Software Project Management	3	0	3
SEN 220	SEN 420	Software Quality Assurance	3	0	3
SEN 220	SEN 447	Software Testing	3	0	3

Program Roadmap

SEMESTER 1						
Prerequisite	**Course Code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
None	GSC 110	Applied Calculus and Analytical Geometry	3	0	3	16
None	CSC 114	Introduction to Information & Communication Technology	2	0	2	
None	CSL 114	Introduction to Information & Communication Technology Lab	0	1	1	
None	ENG 105	Functional English	3	0	3	
None	CSC 113	Computer Programming	3	0	3	
None	CSL 113	Computer Programming Lab	0	1	1	
None	GSC 114	Applied Physics	2	0	2	
None	GSL 114	Applied Physics Lab	0	1	1	

SEMESTER 2						
Prerequisite	**Course Code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
		University Elective-I	3	0	3	17
ENG 105	HSS 120	Communication Skills	3	0	3	
CSC 113	CSC 210	Object Oriented Programming	3	0	3	
CSC 113	CSL 210	Object Oriented Programming Lab	0	1	1	
GSC 114	CEN 120	Digital Logic Design	3	0	3	
GSC 114	CEL 120	Digital Logic Design Lab	0	1	1	
None	GSC 221	Discrete Mathematics	3	0	3	

SEMESTER 3						
Prerequisite	**Course Code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
None	GSC 122	Probability and Statistics	3	0	3	17
GSC 110	GSC 211	Multivariable Calculus	3	0	3	
CEN 120	CEN 324	Computer Organization & Assembly Language	3	0	3	
CEN 120	CEL 324	Computer Organization & Assembly Language Lab	0	1	1	
CSC 113	CSC 221	Data Structures and Algorithms	3	0	3	
CSC 113	CSL 221	Data Structures and Algorithms Lab	0	1	1	
None	CSC 307	Professional Practices	3	0	3	

SEMESTER 4						
Prerequisite	**Course Code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
		University Elective-II	3	0	3	17
None	CSC 220	Database Management Systems	3	0	3	
None	CSL 220	Database Management Systems Lab	0	1	1	
None	CEN 222	Data communication and Networking	3	0	3	
None	CEL 222	Data communication and Networking Lab	0	1	1	
None	CSC 315	Theory of Automata	3	0	3	
GSC 110	GSC 210	Differential Equations	3	0	3	

SEMESTER 5						
Prerequisite	**Course Code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
CSC 221	CSC 320	Operating Systems	3	0	3	18
CSC 221	CSL 320	Operating Systems Lab	0	1	1	
None	SEN 220	Software Engineering	3	0	3	
CSC 315	CSC 323	Compiler Construction	2	0	2	
CSC 315	CSL 323	Compiler Construction Lab	0	1	1	
CSC 221	CSC 321	Design and Analysis of Algorithms	3	0	3	
None	GSC 121	Linear Algebra	3	0	3	
None	ISL 101	Islamic Studies / Ethics	2	0	2	

SEMESTER 6						
Prerequisite	**Course Code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
CSC 210	CSC 325	Artificial Intelligence	3	0	3	16
GSC 221	CSL 325	Artificial Intelligence Lab	0	1	1	
GSC 210	GSC 320	Numerical Analysis	3	0	3	
HSS 120	HSS 320	Technical Writing & Presentation Skills	3	0	3	
		Elective 1 (3+0 or 2+1)	-	-	3	
		Elective 2 (3+0 or 2+1)	-	-	3	

SUMMER						
Prerequisite	**Course code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
		Internship	0	0	0	0

SEMESTER 7						
Prerequisite	**Course code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
NONE	ESC 498	Project-I	0	3	3	17
CSC 320	CEN 455	Parallel & Distributed Computing	3	0	3	
None	PAK 101	Pakistan Studies	2	0	2	
		University Elective-III	3	0	3	
		Elective 3 (3+0 or 2+1)	-	-	3	
		Elective 4 (3+0 or 2+1)	-	-	3	

SEMESTER 8						
Prerequisite	**Course code**	**Course Title**	**Theory**	**Lab**	**CR**	**CR/Sem**
NONE	ESC 499	Project-II	0	3	3	15
CEN 222	CSC 407	Information Security	3	0	3	
		University Elective-IV	3	0	3	
		Elective 5 (3+0 or 2+1)	-	-	3	
		Elective 6 (3+0 or 2+1)	-	-	3	
Total Credit Hours:						**133**

Course Contents

APPLIED CALCULUS & ANALYTICAL GEOMETRY

Course Code:	GSC110
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The main aim of this course is to introduce students with the fundamental concepts of calculus and analytical geometry. In addition to understanding of concepts, one of the key goals is to enable students to apply the learned concepts to solve various practical problems. The course will serve to help the Computer Science students to understand and solve the problems involving Mathematical and logical concepts in other courses and problem domains.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Describe real value functions of one and more variables	1	C1
2. Apply the concepts of limits and continuity to solve problems in differential calculus	3	C3
3. Solve applied problems by applying concepts of Integration	3	C3

Course Contents

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normal lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)		✓	✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Calculus and Analytic Geometry by Kenneth W. Thomas.
2. Calculus by Stewart, James.
3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole.

INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGY	
Course Code:	CSC114
Credit Hours:	2
Pre-requisite:	None

Course Objectives

The objectives of this course include making the students learn the fundamental concepts of computing technologies and enable them to apply the concepts of number systems, programming, and databases. Furthermore, understanding networking and internet technologies also makes part of this course.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Describe** the components of a computer system	1	C1
2. **Understand** the fundamentals of operating systems, databases, and number systems	2	C2
3. **Explain** Networking and Internet Technologies	2	C2

Course Contents

Basic Definitions and Concepts, Hardware: Computer Systems and Components. Storage Devices, Number Systems. Software: Operating Systems, Programming and Application Software, Introduction to Programming, Databases and Information Systems, Networks, Data Communication, The Internet, Browsers and Search Engines, The Internet: Email, Collaborative Computing and Social Networking, The Internet: E-Commerce, IT Security, and other issues: Ad hoc networks, Introduction to cloud computing and virtualization.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	✓
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Livesley, Robert Kenneth (2017) An introduction to automatic digital computers. Cambridge University Press.
2. June P & Dan O (2015), New Perspective on Computer, 16/e, Cengage Learning.
3. Charles S. Parker, (2014) Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
4. Deborah (2013), Understanding Computers, 14/e, Cengage Learning.
5. Gary B (2012), Discovering Computers, 1/e, South Western.
6. Peter Norton (2011), Introduction to Computers, 7 /e, McGraw-Hill

INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGY LAB	
Course Code:	CSL114
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The objectives of this course include making the students familiar with computer hardware and software and introduce them to common computer applications. Students will learn basic skills of different computer applications, apply concept of designing simple web pages and databases and implement the basic networks using different network topologies.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Observe** the operations of various components of computing system	1	P1
2. **Practice** the basic computer application software like MS Word, MS Excel, MS Power Point, MS Access etc.	5	P3
3. **Demonstrate** the use of communication and networking	6	P4

Course Contents

The basics of Computer Science will be covered in the ICT lab. This lab is designed to teach the skills needed to become proficient with the basic primary Microsoft applications: Excel, PowerPoint, Access and Word, basics of Web Programing: Basic HTML and how to create basic networks using different network topologies

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Livesley, Robert Kenneth (2017) An introduction to automatic digital computers. Cambridge University Press.
2. June P & Dan O (2015), New Perspective on Computer, 16/e, Cengage Learning.
3. Charles S. Parker, (2014) Understanding Computers: Today and Tomorrow, Course Technology, 25
   Thomson Place, Boston, Massachusetts 02210, USA
4. Deborah (2013), Understanding Computers, 14/e, Cengage Learning.
5. Gary B (2012), Discovering Computers, 1/e, South Western.
6. Peter Norton (2011), Introduction to Computers, 7 /e, McGraw-Hill

FUNCTIONAL ENGLISH

Course Code:	ENG105
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course incorporates four Basic English language skills – reading, writing, speaking and listening, with chief emphasis on class participation resulting in both written and verbal responses.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate English listening skills to function successfully in target language listening situation.	7	A1
2. Exhibit English reading skills to comprehend various aspects of the nature of the reading material.	7	A1
3. Practice English speaking skills to express effectively through speech.	7	A2
4. Demonstrate formal and informal English writing skills to express ideas and convey message to target readers.	7	C3

Course Contents

Basic English Composition, Introduction, Sentence and Structure, Components of a sentence, Types of Sentences, Subject verb agreement – Rules and common mistakes, The Reading Process, Skimming and scanning, reading for gist, Sample Reading Passages, How to look for contextual meanings, Types of readings, Looking for meaning, Writing a summary, Mechanics of writing, Brain storming and drafting, Writing a topic sentence and supporting details, Essays and types – basic, Basics of grammar in writing, Tenses, Reported speech, Verbs and types, The writing Process, Cohesion and coherence – introduction, Essays and types – basic, Story writing/ narrating an incident – structure and process, Common grammatical mistakes, Report Writing, Dialogue Writing, Oral Communication, Conversational Skills/Speaking, Presentation skills, Debate and speech, Agreements and disagreements, listening process, listening for specific information, Listening for gist, Basics of Grammar

– Grammar in Speech, Modifiers, Articles and determiners, Role Play, Phonetics and Phonology, Vowels and consonants, Stress and syllabification, Commonly mispronounced words, Sample audios and practice.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)	✓	✓	✓	✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342-1.
2. English Grammar in Use with Answers: A Self Study Reference and Practice Book by Raymond Murphy. Cambridge University Press, 2012.
3. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills.
   Third Impression 1992. ISBN 0 19 453402 2
4. Intermediate Listening Comprehension: Understanding and Recalling Spoken English by Patricial Dunkel and Phyllis L. Lim, Third Edition. ISBN 1 4130 1257 4.
5. College Writing Skills with Readings by John Langlan 9th Edition

COMPUTER PROGRAMMING

Course Code:	CSC113
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The main course objectives are:

- To familiarize students with basic structured programming concepts.
- To emphasize upon problem analysis, logic building and program development skills.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of the basic concepts of programming	2	C2
2. **Exhibit** logic building ability using basic programming concepts	3	C2
3. **Apply** programming concepts to model requirements and solve simple computing problems using a high-level programming language	4	C3

Course Contents

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Diane Zak, An Introduction to Programming with C++, Eighth Edition, Course Technology
2. Paul. Deitel and Harvey. Deitel. , C++ How To Program, Eight Edition, Pearson, International Edition,
3. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Que Publishing,
4. Behrouz A. Forouzan, Richard F. Gilberg, Computer Science – A Structured Approach using C++, Second Edition, Cengage Learning,
5. C. M. Aslam, T. A. Qureshi, Programming with C++ Object-Oriented Programming, First Edition, Polymer Books

COMPUTER PROGRAMMING LAB

Course Code:	CSL113
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The main course objectives are:

- To practice basic structured programming concepts.
- To develop problem analysis, logic building, program design and debugging skills.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate the understanding of programing language syntax and its usage	2	P2
2. Apply basic programming structures for logic construction	3	P3
3. Translate the devised solutions into computer programs and test the implementation	5	P3

Course Contents

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			✓
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Diane Zak, An Introduction to Programming with C++, Eighth Edition, Course Technology
2. Paul. Deitel and Harvey. Deitel. , C++ How To Program, Eight Edition, Pearson, International
Edition,
3. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Que Publishing,
4. Behrouz A. Forouzan, Richard F. Gilberg, Computer Science – A Structured Approach using C++, Second Edition, Cengage Learning,
5. C. M. Aslam, T. A. Qureshi, Programming with C++ Object-Oriented Programming, First Edition, Polymer Books

APPLIED PHYSICS

Course Code:	GSC114
Credit Hours:	2
Pre-requisite:	None

Course Objectives

Physics is the study of how the world works. This course introduces the physical world concepts that will be required in advance courses. This course will provide students with the knowledge of a wide variety of electric and magnetic phenomena. The course initiates with the basics of electricity at the atomic level and takes it to the circuit level for electric circuit analysis and design. Majority of the course is dedicated for electric and magnetic fields, forces, elements and their applications. Additionally, it also aims to provide introductory knowledge of wave theory and thermodynamic theory and optics in conjunction with their applications.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Comprehend** the working knowledge of fundamental laws of physics.	1	C2
2. **Apply** the knowledge of fundamental laws to solve various real-world problems	1	C3
3. **Analyze** different physical problems using the knowledge gained from different areas like electromagnetism, optics etc.	3	C4

Course Contents

Electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss' Law, Application of Gauss' Law, Spherically symmetric charge distribution, A charge isolated conductor, Electric potential energy, Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential , Electric current, Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, The Hall effect, The magnetic force on a current, The Biot- Savart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroids, Faraday's experiments, Faraday's Law of Induction, Lenz's law, Motional emf, Induced electric field, Induced electric fields, The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓	✓	
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker
2. Narciso Garcia, Arthur Damask, Steven Schwarz., “Physics for Computer Science Students”, Springer Verlag, 1998
3. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics, 10th Edition
4. Young and Freedman,” University Physics”, 13th Edition

APPLIED PHYSICS LAB

Course Code:	GSL114
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The key objectives of this course include:

1. To gain practical knowledge by applying the experimental methods and correlate the findings with the theoretical concepts in Physics.
2. To learn the usage of electrical and optical systems for various measurements.
3. To apply analytical techniques to data collected from experiments.
4. To discuss the basic principles of scientific concepts and apply these concepts while working in teams.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Develop the ability to record readings using different measurements tools.	5	P3
2. Demonstrate an understanding of basic laws of Physics through relevant experimentation.	6	P4
3. Show knowledge of constructing an electronic circuit for a given set of constraints.	3	P5

Course Contents

- Introduction to Measuring equipment (i.e., Vernier Caliper and Screw Gauge)
- Introduction to recently used electronic components.
- Finding resistance using color coding techniques & connecting them in series and parallel.
- Familiarization with analog and digital multi meter Vernier Caliper and Screw Gauge
- Verification of Ohm’s Law.
- Voltage divider and current divider.
- Kirchhoff’s voltage law & Kirchhoff’s current law.
- Magnetic lines of force.
- Familiarization with function generator and oscilloscope.
- Familiarization with light dependent resistor (LDR).
- Generating waveforms of different frequencies on oscilloscope.
- Familiarization with Semiconductor Diode biasing Characteristics.
- Familiarization with capacitor coding
- Charging and discharging of a capacitor.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)	✓		
PLO6 (Individual and Teamwork)		✓	
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Fundamentals of Physics (Extended) by Resnick and Walker, Publisher: Wiley, 10th edition (2015).
2. Narciso Garcia, Arthur Damask, Steven Schwarz. “Physics for Computer Science Students”, Springer Verlag (1998).
3. Essential Calculus-based Physics Study Guide Workbook: The Laws of Motion by Chris McMullen, Publisher: Zishka Publishing (2016)

COMMUNICATION SKILLS

Course Code:	HSS120
Credit Hours:	3
Pre-requisite:	Functional English

Course Objectives

The general focus of the course is on clarifying and broadening the students' understanding of verbal and written English by comparing what they already know. The aim is to provide the students with a course that focuses on their needs as learners of English in the present day. Accordingly, the emphasis will be on the communicative use of contemporary English for practical purposes. The course will, therefore, provide material not only to extend the students' general language proficiency, but also to systematically develop their abilities to use English as a tool for study and to prepare them for their future careers.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Participate actively in group discussions by exercising attentive listening and constructive debate.	6	A2
2. Initiate a conversation and communicate effectively by employing intermediate-to advanced level English vocabulary.	7	A3
3. Express or present ideas independently in front of an audience and effectively respond to queries.	7	A3
4. Write formal business letters by applying technical writing skills.	7	C3

Course Contents

Business Writing: Seven Cs of Communication, Business Writing Styles, Business Memos, Business Emails, Tenders and Quotations, Billing and Invoicing, Common Writing Errors, Useful Vocabulary and Phrases, Personal Documents, Oral Communication: Verbal and non-verbal communication, Conducting meetings, Small group communication, Taking minutes, Presentation Skills: Presentation Strategies, Defining the Objective, scope and audience of the presentation, Material gathering and material organization strategies, Time management, Opening and concluding, Use of Visual audio- visual aids, Delivery and presentation, Activities Involved: Interactive session of students for communication skills followed by assessment with defined rubrics.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)	✓			
PLO7 (Communication)		✓	✓	✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Anchor in English-II (Lessons 1-5), A SPELT Publication
2. Christopher Fry, “Summary Writing (Book-I)”, Oxford University Press
3. College Essays by John Langlan
4. Barron’s TOFFLiBT Edition
5. Communication Skills for Engineers by Sunita Marshal and C.Muralikrishna
6. Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342
7. Practical English Grammar Exercises 1 by A. J. Thomson and A. V. Martinet. Third edition. Oxford University Press. ISBN 978-0-19-431349-0.
8. A Practical Guide to Business Writing: Writing in English for Non-Native Speakers by Khaled Mohamed Al Maskari. Wiley. ISBN 978 1 118 41079 0

OBJECT ORIENTED PROGRAMMING

Course Code:	CSC210
Credit Hours:	3
Pre-requisite:	Computer Programming

Course Objectives

The key objectives of this course include:

1. To understand the differences between traditional procedural design and object-oriented design
2. To provide a clear understanding of object-oriented concepts and their implementation
3. To analyse a problem from the perspective of the object oriented paradigm
4. To design and implement object oriented solutions to given problems

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Develop an understanding** of the underlying concepts of object-oriented paradigm	1	C2
2. **Apply** object-oriented concepts in solving computing problems	2	C3
3. **Design and implement** object-oriented solutions for small real-world problems	4	C4

Course Contents

Program design technique, Procedural vs. Object oriented Programming, Principles of Object-oriented Programming, Data Abstraction, Encapsulation, Classes and Objects, Function and Operator Overloading, Single and Multiple Inheritance, Polymorphism and Abstract Classess, Exception Handling, Stream I/O and File Processing, Class Templates.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. C++ How to Program, by Deitel & Deitel, 10th Edition, 2017, Pearson.
2. Matt Weisfeld (2018), The Object-Oriented Thought Process, 4th Edition, Wiley.
3. Joyce Farrell (2019), An Object-Oriented Approach to Programming Logic and Design, 5th Edition Hall, Course Technology.

OBJECT ORIENTED PROGRAMMING LAB

Course Code:	CSL210
Credit Hours:	1
Pre-requisite:	Computer Programming

Course Objectives

The key objectives of this course include:

1. To provide basic understanding of the tool used for the implementation of object-oriented concepts
2. To practice the implementation of object-oriented concepts using a programming language
3. To design and implement object oriented programs for computational problems.
4. To test and debug object oriented programs.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate an understanding of object-oriented design concepts and their mapping to object-oriented programming	4	P3
2. Implement and debug object-oriented solutions for problems involving multiple classes	5	P4
3. Demonstrate effective communication and teamwork	6	A2

Course Contents

Program design technique, Procedural vs. Object oriented Programming, Basic Principles of Object- oriented Programming, Data Abstraction, Encapsulation, Classes and Objects, Function and Operator Overloading, Single and Multiple Inheritance, Polymorphism and Abstract Classes, Exception Handling, Stream I/O and File Processing, Class Templates.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)	✓		
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. C++ How to Program, by Deitel & Deitel, 10th Edition, 2017, Pearson.
2. Matt Weisfeld (2018), The Object-Oriented Thought Process, 4th Edition, Wiley.
3. Joyce Farrell (2019), An Object-Oriented Approach to Programming Logic and Design, 5th Edition Hall, Course Technology.)

DIGITAL LOGIC DESIGN	
Course Code:	CEN120
Credit Hours:	3
Pre-requisite:	Applied Physics

Course Objectives

1. To understand fundamentals of Digital Logic Design, binary systems and digital systems
2. To understand the implementation of Boolean algebra and K-maps for simplification of digital logic circuits.
3. To understand combinational logic i.e., coders, decoders, multiplexers, de-multiplexers, adders etc.,
4. To get familiarization with different types of designs in sequential logic circuits i.e. FFs, Shift registers counters through state machines etc.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understanding** of the Boolean Algebra, Boolean Functions, Combinational and Sequential Logic and PLDs	1	C2
2. **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques	2	C3
3. **Understand** the relationship between abstract logic characterizations and practical electrical implementations.	3	C2

Course Contents

Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Digital Logic Design by Morris Mano, Michale D. Ciletti 5rd edition Publisher Pearson Copy Right 2015.
2. Digital Fundamentals by Thomas L. Floyd, 10th edition, Publisher: Pearson 2015
3. Digital Electronics : An Introduction To Theory And Practice by William Gothmann H, 2011
4. Digital Electronics by John Morris, 2012

DIGITAL LOGIC DESIGN LAB	
Course Code:	CEL120
Credit Hours:	1
Pre-requisite:	Applied Physics

Course Objectives

1. To Identify and work with number systems and codes.
2. To Understand logic gates, combinational circuits, Boolean Algebra, and simplification by using Karnaugh maps.
3. To Design and understand the working of simple logic circuits like comparator, adders, encoder, decoders, multiplexers and de-multiplexers.
4. To Understand the working of latches, flip flops, synchronous and asynchronous counters, clocks, shift registers.
5. To Understand memory structure and basic operations.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the tools and techniques for the design of digital electronic circuits	1	C2
2. **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques	2	P3
3. **Apply** the acquired knowledge to simulate and implement small-scale digital circuits	3	P4

Course Contents

Implementation of : AND,OR NAND ,NOR and NOT gates, simple circuits from given expression, gates using universal gates, parity generator with checker, half adder and full adder, multiplexer using gates , decoder using basic gates ,adder and subtractor using Integrated circuits.SR latches & SR latches with control bit, D Latch & D Flip Flops, SR Flip Flop, JK Flip Flop, Toggle Flip Flop.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Digital Logic Design by Morris Mano, 5th Edition, Publisher: Pearson, 2013
2. Digital Fundamentals by Thomas L. Floyd, 10th edition, Publisher: Pearson 2011
3. Digital Electronics : An Introduction To Theory And Practice by William Gothmann H, 2011
4. Digital Electronics by John Morris, 2012

DISCETE MATHEMATICS

Course Code:	GSC221
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To provide students with a solid understanding of Discrete Mathematics.
2. To introduce students to the fundamental as well as advanced concepts of Set theory, Algorithms, Functions, Mathematical reasoning , Graph Theory, and Trees.
3. To enable students improve problem-solving skills of enumerating objects using combinatorial analysis.
4. To enable students learn about the abstract Mathematical structures used to represent discrete objects and relationships between these objects.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of the key concepts of Discrete Structures.	1	C2
2. **Relate** various discrete structures with different areas of Computer Science.	2	C2
3. **Apply** formal logic proofs and/or informal, but rigorous, logical reasoning to real world problems.	3	C3
4. **Develop** pseudocodes of algorithms for standard computing problems.	4	C3

Course Contents

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, euler graph, Hamiltonian path, rooted trees, traversals.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Discrete Mathematics and Its Applications by Kenneth H. Rosen
2. Discrete Mathematics with Applications by Susanna S. Epp
3. Discrete Mathematics by Richard Johnson Baugh
4. Discrete Mathematical Structures by Kolman, Busby & Ross
5. Discrete and Combinatorial Mathematics: An Applied Introduction by Ralph P. Grimaldi
6. Logic and Discrete Mathematics: A Computer Science Perspective by Winifred Grassman

PROBABILITY & STATISTICS

Course Code:	GSC122
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To familiarize students with various statistical concepts and methods and enable them to develop statistical reasoning.
2. To understand and apply the concepts of Probability theory.
3. To provide students, the knowledge of different Probability distributions and their applications in Computer Science.
4. To enable the students to learn and apply the tools for curve fitting via Linear Regression and Correlation.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** and **express** the basic understanding of probability and statistics.	1	C2
2. **Demonstrate** an ability to use descriptive techniques to describe the statistical data.	2	C2
3. **Apply** inferential statistical methods to solve problems.	3	C3
4. **Analyze** and investigate any given data distribution.	3	C4

Course Contents

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two- Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	✓
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson.
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 4TH edition.
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill.

MULTIVARIABLE CALCULUS

Course Code:	GSC211
Credit Hours:	3
Pre-requisite:	Applied Calculus and Analytical Geometry

Course Objectives

1. Manipulate vectors to perform geometrical calculations in three dimensions.
2. Calculate and interpret derivatives up to three dimensions.
3. Integrate functions of several variables over curves and surfaces.
4. Develop Mathematical maturity to undertake higher level studies in mathematics and related fields.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Comprehend** the basic concepts and techniques of differential and integral calculus of functions of several variables.	1	C2
2. **Apply** the knowledge of different transforms to solve relevant problems.	2	C3
3. **Analyze** the given problems and apply integrals to compute physical quantities like area/volume.	3	C4

Course Contents

Functions of Several Variables and Partial Differentiation, Relative changes, differentials, local and absolute extrema and saddle points, Multiple Integrals, Line and Surface Integrals. Green's and Stoke's Theorem. Fourier Series: periodic functions, Functions of any period P-2L, Even & odd functions, Half Range expansions, Fourier Transform; Laplace Transform, Z-Transform.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Multivariable Calculus, 6th edition James, Stewart 2007 Cengage Learning publishers.
2. Calculus and Analytical Geometry, 6th edition. Swokowski, Olinick and Pence.1994. Thomson Learning EMEA, Ltd.
3. Multivariable Calculus, 5th edition Howard, A. Albert, H. 1995, John Wiley.
4. Calculus by Thomas Finny 11th or 12th edition

COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE LAB

Course Code:	CEL324
Credit Hours:	1
Pre-requisite:	Digital Logic Design

Course Objectives

The objectives of this lab include:

1. Familiarizing with Assembly Language directives, macros, operators, and program structures
2. Learning Programming methodology to be able to create system level software tools and application programs.
3. Understanding of interrelationship between hardware and software.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Acquire** the basic knowledge of computer organization, computer architecture and assembly language	2	C2
2. **Implement** the arithmetic logical operation using Instruction set architecture (ISA) at ALU & memory units	3	P3
3. **Solve** the problems related to computer organization and assembly language	3	P4

Course Contents

The basics of computer architecture and low-level programming, i.e., assembly code and hardware manipulation. Basic concepts of computer architecture and machine instructions, Memory access and storage, Instruction execution, Data representation and transfer, Digital arithmetic, Memory storage and addressing methods, Procedures and interrupts, Conditional processing.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Modern X86 Assembly Language Programming: Covers x86 64-bit, AVX AVX2 and AVX-512 (2nd Edition), Daniel Kusswurm December 6, 2018.
2. Assembly Language Programming & Architecture (ARM books, Band 1)12. August 2016.
3. Intel Microprocessors 8086 8088 -Architecture, Programming, and Interfacing (8th Edition) 2014.

COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE

Course Code:	CEN324
Credit Hours:	3
Pre-requisite:	Digital Logic Design

Course Objectives

1. To introduce the organization of computer systems and usage of assembly language for optimization and control.
2. To expose the low-level logic employed for problem solving while using assembly language as a tool.
3. To familiarize with Assembly Language, directives, macros , operators , and program structures.
4. To learn programming methodology to be able to create system level software tools.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Identify** the major components of computer architecture, and explain their purposes and interactions	1	C2
2. **Simulate** the internal representation of data, and show how data is stored and accessed in, I/O modules, and the interconnecting components of the computer systems	2	C3
3. **Analyze** the relationships between hardware architecture and its instruction set.	3	C4

Course Contents

Basics of computer architecture and low-level programming, i.e., assembly code and hardware manipulation. The basic concepts of computer architecture and machine instructions. Memory access and storage; Instruction execution. Assembly language. Computer organization; Data representation and transfer. Digital arithmetic, Memory storage and addressing methods, Procedures and interrupts, Conditional processing.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Modern X86 Assembly Language Programming: Covers x86 64-bit, AVX AVX2 and AVX-512 (2nd Edition), Daniel Kusswurm December 6, 2018.
2. Assembly Language Programming & Architecture (ARM books, Band 1)12. August 2016.
3. Intel Microprocessors 8086 8088 -Architecture, Programming, and Interfacing (8th Edition) 2014.

DATA STRUCTURES AND ALGORITHMS	
Course Code:	CSC221
Credit Hours:	3
Pre-requisite:	Computer Programming

Course Objectives

The primary objective of the course is to help students understand the importance of data structures and well-designed algorithms for efficient management of computing resources while programming. Popularly employed linear and nonlinear data structures are described from the perspective of their specification, application, and implementation. Several sorting and searching techniques are also discussed to help students design efficient solutions for real life problems. Basic knowledge of algorithm's complexity analysis is also provided for identification of time costly processes.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Explain** and **compare** different data structures and their applications	1	C2
2. **Apply** appropriate data structures according to the given scenarios and application domain.	2	C3
3. **Analyze** time complexity of different algorithms	2	C4
4. **Design** efficient algorithm(s) to solve real-world problems	4	C6

Course Contents

Abstract Data Types (ADTs) , Linear data structures (Stacks, Queues, Linked list), Non-linear data structures (Trees, Graphs), Recursion and recursive algorithms, Sorting Algorithms (Bubble, Insertion, Selection, Quick, Merge, Shell, Heap), Searching (Linear, Binary, Depth First, Breadth First, Shortest Path, Minimum Spanning Trees), Hashing and Collision resolution techniques (Open Addressing, Separate Chaining, Double Hashing), Data Compression (Huffman's Code), Complexity Analysis of Algorithms (Big-O notation)

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓	✓	
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss, 7th Edition, Published by Addison-Wesley, 2019.
2. Data Structures and Algorithms in C++, by Drozdek Adam, 6th Edition, 2020
3. Data Structures and Algorithms using C & C++, Augenstein & Tenenbaum, 2019.
4. C++ Plus Data Structures, 7th Edition, Nell Dale, Jones and Bartlett Learning, 2020.
5. Data Structures using C++, Varsha H. Patil, 6th Edition, Oxford University Press, 2018.

DATA STRUCTURES & ALGORITHMS LAB	
Course Code:	CSL221
Credit Hours:	1
Pre-requisite:	Computer Programming

Course Objectives

This lab is aimed at implementing common linear and nonlinear data structures, sorting techniques, and hashing algorithms to solve various programming tasks with efficiency.
The primary objectives of the course include the following.

1. Implement efficient data structures for real world problem solving.
2. Design & implement various operations on commonly used linear/non-linear data structures.
3. To employ efficient techniques for searching and sorting data.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Implement different linear and non-linear data structures	3	P3
2. Construct programs for problems and application domain by using appropriate data structures.	4	P4
3. Demonstrate effective teamwork in solving problems	6	A2

Course Contents

The key concepts covered in the course include basics of data structures and abstract data types, algorithms, linear data structures: stacks, queues, linked lists and variants, non-linear data structures: trees, heaps and graphs, operations on data structures, sorting algorithms, hashing and complexity analysis of algorithms.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)	✓		
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss, 7th Edition, Published by Addison-Wesley, 2019.
2. Data Structures and Algorithms in C++, by Drozdek Adam, 6th Edition, 2020
3. Data Structures and Algorithms using C & C++, Augenstein & Tenenbaum, 2019.
4. C++ Plus Data Structures, 7th Edition, Nell Dale, Jones and Bartlett Learning, 2020.
5. Data Structures using C++, Varsha H. Patil, 6th Edition, Oxford University Press, 2018

PROFESSIONAL PRACTICES

Course Code:	CSC307
Credit Hours:	3
Pre-requisite:	None

Course Objectives

- To enhance key factors of interpersonal relations.
- To build social ethics.
- To know organizational behavior so that individual and team works can be done in a more professional way without compromising organization principles and without hurting others interests.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Identify the content of religious, national, or international law dealing with professional ethics	8	A2
2. Apply the knowledge of ethics in their personal and professional life	9	A3
3. Gain the ability to enhance key factors of interpersonal relations, to follow and implement the acquired knowledge of ethical skills in given situations by controlling his/her temperament.	10	A4

Course Contents

Computing Profession, Computing Ethics, Philosophy of Ethics. The Structure of Organizations, Finance and Accounting, Anatomy of a Software House, Computer Contracts, Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)	✓		
PLO9 (Ethics)		✓	
PLO10 (Life-long Learning)			✓

Resources

1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
2. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN10: 0131112414
3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
4. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN- 10: 0819193747

DATABASE MANAGEMENT SYSTEMS	
Course Code:	CSC220
Credit Hours:	3
Pre-requisite:	None

Course Objectives

They key objectives of this course include:

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
- To understand and use data manipulation language to query, update, and manage a database.
- To develop an understanding of essential DBMS concepts such as: database security, integrity, and concurrency.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** the fundamental concepts of databases	2	C2
2. **Apply** different database models to design conceptual, logical, and physical databases	4	C3
3. **Apply** queries to extract information from databases	5	C3
4. **Analyze** user requirements to design a database for the given scenarios	4	C4

Course Contents

Basic database concepts, Database approach vs. file-based system, Database architecture, Three level schema architecture, Data independence, Relational data model, Attributes, schemas, tuples, domains, relation instances, keys of relations, Integrity constraints, Relational algebra, selection, projection, Cartesian product, Types of joins, Normalization, functional dependencies, normal forms , Entity relationship model, entity sets, attributes , Relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub- queries in SQL, Grouping and aggregation in SQL , Concurrency control, Database backup and recovery, Indexes, NoSQL systems.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓			
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)		✓		✓
PLO5 (Modern Tool Usage)			✓	
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom
3. Database System Concepts, 7th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke

DATABASE MANAGEMENT SYSTEMS LAB

Course Code:	CSL220
Credit Hours:	1
Pre-requisite:	None

Course Objectives

Students successfully completing this course should be able:

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
- To understand and use data manipulation language to query, update, and manage a database.
- To develop an understanding of essential DBMS concepts such as: database security, integrity, and concurrency.
- To familiarize with the concepts of distributed database, and intelligent database, Client/Server (Database Server), data warehousing and data mining.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Practice** writing SQL commands to perform different tasks	4	P3
2. **Make** ER diagrams as to analyze and interpret data design of database	3	P4
3. **Make** a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS	5	P4

Course Contents

- Introduction to DBMS, SQL, Installation of tool, and interaction with tool.
- Overview of The SQL Query Language, Database Design, Data retrieval Language, Query Processing.
- Basic Query Structure, Conditional Queries Additional Basic Operations
- Data Definition Language
- Data Manipulation Language
- Set operations and Aggregate functions.
- SQL Case Study
- Entity Relationship Diagram and Relational Database Design, Entity Relationship Model
- Design Process, Modeling Constraints, E-R Diagram

- Group By, Having, Order By
- Views
- Sub-queries
- JOINS, Self-Join, Left Outer Join, Inner Join, Full Outer Join
- Application Design and Development Using .Net framework, Microsoft Visual Studio
- Transactions and Concurrency, Backup and Recovery

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)	✓		
PLO5 (Modern Tool Usage)			✓
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Database System Concepts, Sixth Edition. Avi Silberschatz, Henry F. Korth, S. Sudarshan.
   McGraw-Hill, 2010. ISBN 0-07-352332-1
2. Modern Database Management by Fred McFadden, Jeffrey Hoofer, Mary Prescott, Prentice Hall; 11th Edition (July 26, 2012). ISBN-10: 0132662256
3. Fundamentals of Database Systems by R. Elmasri and S. Navathe. 6th Edition, Addison-Wesley (2010). ISBN-10: 0136086209.

DATA COMMUNICATION & NETWORKING	
Course Code:	CEN222
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To develop understanding of the concepts related to Data Communication & Networks
2. To provide the detailed insight into the layered structure of OSI and TCP/IP Models.
3. To enable to apply knowledge of Data Communication & Networks and layered models in analysis, problem solving and developing small and medium scale networks**.**

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** basic principles and functionalities of Data Communication and Networks.	1	C2
2. **Explain** the services and functions provided by each layer in the Internet protocol stack.	2	C2
3. **Identify** various internetworking devices and protocols, and their functions in a network.	2	C3

Course Contents

Network Models: Communication Model, Layered Protocol Architecture, OSI Reference Model, TCP/IP Architecture. **Physical Layer and Media**: Data and Signals, Digital Transmission, Analog Transmission**,** Bandwidth Utilization: Multiplexing**,** Switching**, Data Link Layer:** Error Detection and Correction, Data Link Control, Multiple Access, Ethernet, LAN and VLAN. Network Layer: Logical Addressing, Internet Protocol, IP Packet (IPv4), IP Addressing and Routing: IP Classes and Subnetting, Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Internet Control Message Protocol (ICMP), Internet Group Management Protocol (IGMP). **Routing Algorithms:** Link State Routing, Distance Vector Routing, Address Mapping, Error Reporting and Multicasting, Delivery, forwarding and routing. **Transport Layer:** Process to Process Delivery: UDP, TCP and SCTP, Congestion Control. **Application Layer:** Domain Name System (DNS), Electronic Mail and File Transfer, WWW and HTTP.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	✓
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Behrouz A. Forouzan, “TCP/IP Protocol Suite”, McGraw-Hill. (Latest Edition)
2. A. Leon-Garcia, “Communication Networks”, McGraw-Hill. (Latest Edition)
3. William Stallings, “Data and Computer Communication”, Prentice Hall. (8th Edition)

DATA COMMUNICATION & NETWORKING LAB	
Course Code:	CEL222
Credit Hours:	1
Pre-requisite:	None

Course Objectives

This is a basic level lab course emphasizing on the network design and configuration of devices in a network. This lab familiarizes students with IP addressing, its classes and classless IP addressing technique, configurations of Switches and Routers and application of different switching and routing protocols. At the end of the course, students are expected to be able to design, analyze and simulate medium-sized networks.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Make** different cable types.	1	P2
2. **Apply** and simulate different routing protocols like RIP, OSPF, NAT and ACL.	5	P3
3. **Build** Computer Network (s) on various topologies.	6	P3

Course Contents

- Basic cable construction and testing (straight, cross-over)
- Introduction to Packet Tracer and building and testing a Peer-to-Peer network physically and on packet Tracer.
- Introduction to Switch and Router & their Command Line Interface (CLI) fundamentals.
- Establishing a console session with CISCO Router 3900 Series Using HyperTerminal, retrieving configurations from NVRAM and TFTP server and configuring DHCP.
- Building and testing a Router based network using Static Routing.
- Building and testing VLAN and Inter-VLAN in switch domain network.
- Configuring RIP between routers.
- Configuring Access Control Lists (ACLs) on a Router.
- Configuring OSPF and Mutli-area OSPF between routers.
- Configuring Network Address Translation (NAT) on a Router.
- Configuring Wired LANS and WLANs in Wireshark Packet Analyzer.
- Configuring IoTs in Packet Tracer
- Configuring DSL and VoIP in Packet Tracer.
- Open-Ended Lab

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

Tools

- Packet Tracer 7.2
- Wireshark Network Analyzer 2.6.0
- Hyper Terminal
- Cisco Switch 2600 series
- Cisco Router 3900 series

THEORY OF AUTOMATA

Course Code:	CSC315
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course introduces students with the fundamental concepts of automata theory and formal languages, to form basic models of computation which provide foundation of many branches of computer science, e.g., compilers, software engineering, concurrent systems, etc.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** the different concepts in automata theory and formal languages.	2	C2
2. **Analyze** properties of languages, grammars, and automata with formal methods.	3	C4
3. **Design** grammars and models for different languages	4	C5

Course Contents

Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene's theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars, CFGs, Derivations, derivation trees and ambiguity, PDA, Simplifying CFLs, Chomsky Normal form, grammars and parsing, Turing Machines, TM encoding, Universal Turing Machine, Defining Computers by TMs, Introduction to Decidability.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Michael Sipser, *Introduction to the Theory of Computation* (2nd Edition)
2. Introduction to computer theory, Daniel I. A. Cohen, 2nd Edition
3. Introduction to Automata Theory Languages and Computation by Hopcroft, Ulman

DIFFERENTIAL EQUATIONS

Course Code:	GSC210
Credit Hours:	3
Pre-requisite:	Applied Calculus and Analytical Geometry

Course Objectives

1. Enable students to recognize the appropriate Mathematical tools and techniques of differential equations which provide a logical approach to resolve wide variety of problems.
2. Carry out appropriate Mathematical manipulations by using techniques of differential equations to solve the application problems.
3. Interpret the significance of the Mathematical results.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Comprehend** the fundamental concepts of differential equations.	1	C2
2. **Apply** different methods of solving 1^{st} and 2^{nd} order ordinary differential equations.	2	C3
3. **Solve** Partial derivatives in different coordinate systems.	2	C3
4. **Analyze** and subsequently solve physical situations whose behavior can be described by ordinary/partial differential equations.	3	C4

Course Contents

Ordinary Differential Equations of the First Order: Geometrical Considerations, Isoclines, Separable Equations, Equations Reducible to Separable Form, Exact Differential Equations, Integrating Factors, Linear First-Order Differential Equations, variation of Parameters. Ordinary Linear Differential Equations; Homogeneous Linear Equations of the Second Order, Homogeneous Second-Order Equations with Constant Coefficients, General Solution, Real Roots, Complex Roots, Double Root of the Characteristic Equation, Differential Operators, Cauchy Equation, Homogeneous Linear Equations of Arbitrary Order, Homogeneous Linear Equations of Arbitrary Order with Constant Coefficients, Non- homogeneous Linear Equations. Modelling of Electrical Circuits. Systems of Differential Equations. Series Solutions of Differential Equations. Partial Differential Equations: Method of Separation of variables, wave, Heat & Laplace equations and their solutions.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓	✓	
PLO3 (Problem Analysis)				✓
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Advanced Engineering Mathematics Michael, G.1996, Prentice Hall Publishers.
2. Advanced Engineering Mathematics, 7th edition, Erwin, K. 1993, John Wiley & Sons Inc.
3. A First Course in Differential Equation Zill. Prindle. Weber. Schmidt.1996. Brooks/Cole Publishing.
4. Differential Equations with Boundary-Value Problems, Dennis. G. Zill, Michael, R. Cullen. 1996, Brooks/Cole Publishing,
5. Elementary Differential Equations with Applications C. H. Edwards. David, E. 1993. Penney, Prentice Hall.

OPERATING SYSTEMS

Course Code:	CSC320
Credit Hours:	3
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The key objectives of this course include enabling the students to understand the basic components of a computer operating system, and the interactions among the various components. The course will also cover the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	1	C2
2. **Apply** the concepts of memory management, I/O management CPU management and processor management etc.	2	C3
3. **Analyze** the algorithms of the core functions of Operating Systems and explain the major performance issues with respect to the core functions.	3	C4

Course Contents

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

OPERATING SYSTEMS LAB

Course Code:	CSL320
Credit Hours:	1
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The Operating Systems lab aims to enable students different key concepts of Operating Systems. Students will apply system software and tools available in modern operating systems to develop a deeper understanding of the underlying concepts. The labs will also cover the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Implement OS concepts like those of shell scripting, processes, file manipulation and inter-processes communication.	3	P2
2. Demonstrate the knowledge in applying system software and tools available in modern operating systems.	5	P4

Course Contents

Introduction to Operating Systems, Linux Operating System, Introduction and configuration of the Virtual Machine, VMware tools Installation, Ubuntu Installation, Understanding utility Linux Commands, File Commands, Filter and pipes, Introduction to Shell programming, Common Shells, keywords, Shell variables and their types, Metacharacters, Arithmetic operators and expressions, single and multiple user inputs, Positional Parameters in Shell programming, Different types of operators and expressions, Conditional statements, Nested Conditional statements (if-else, switch case), file testing, execution of shell script, Scripts for automation a process e.g. copying contents of one file to another. Command substitution in scripts, Process Creation through fork system call, Sleep Command, Inter-processes Communication, System calls, Implementation of Filing through System calls, CPU scheduling, Multi-Threading, sharing of variables between two or more threads, Synchronization to avoid deadlock, Using Semaphore, Implementation of Synchronization between multiple threads, Signal handling.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2
PLO1 (Academic Education)		
PLO2 (Knowledge for Solving Computing Problems)		
PLO3 (Problem Analysis)	✓	
PLO4 (Design/Development of Solutions)		
PLO5 (Modern Tool Usage)		✓
PLO6 (Individual and Teamwork)		
PLO7 (Communication)		
PLO8 (Computing Professionalism and Society)		
PLO9 (Ethics)		
PLO10 (Life-long Learning)		

Resources

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

SOFTWARE ENGINEERING

Course Code:	SEN220
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The objectives of this course include developing an understanding of Software Engineering and different software development paradigms. Comprehension of the importance of requirements and classifying the requirements and usage of UML in designing a Software also make part of the key objectives. The course also aims to equip the students with the skills required to construct quality software, which is reliable, reasonably easy to understand, modify and maintain.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Describe** various software engineering processes and activities	1	C1
2. **Apply** knowledge of software engineering appropriate to the discipline, particularly in the modeling, design, testing and deployment of software systems.	4	C3
3. **Analyze** and solve small-scale Software Engineering problems	3	C4

Course Contents

Introduction to Software & Software Engineering, Socio-Technical Systems, Emergent System Properties Legacy Systems, and Critical Systems, FAQs about Software Engineering, Professional and Ethical Responsibility, Key challenges in software engineering, Attributes of a quality software, Software Process Models: Process Activities, Plan Driven Models Coping with Change, Plan Driven Models (continued), Incremental Development Processes Spiral Model, Agile Software Development, Agile Processes Plan Driven and Agile development, Requirements Engineering: Functional & non -functional requirements, Requirements Specification Elicitation and Analysis, Requirements Validation, Requirements Engineering Process, System Modeling: Context Model, Interaction Model, Structural Model, Behavioral Model, Design and Implementation: OO, UML Introduction, UML Design Patterns, UML Design Patterns, Use case Introduction, Use case Diagrams, Activity Diagrams, Sequence Diagrams, Package Diagrams, Architectural Design Introduction, Architectural Design Decisions, Architectural Views and Patterns, Software Testing, Development Testing, Release Testing User Testing, Software Evolution

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Software Engineering, 9th Edition, Ian Somerville, Addison-Wesley, 2011
2. Software Engineering Modern Approaches, 2nd Edition, Eric J. Braude, Michel E. Bernstein, Wiley & Sons, INC, 2011
3. UML Distilled A Brief Guide to The Standard Object Modeling Language, by Martin Fowler
4. Object-Oriented Modeling and Design with UML by Michael R Blaha, James R Rumbaugh
5. Designing Flexible Object-Oriented Systems with UML by Charles Richter, Techmedia

COMPILER CONSTRUCTION

Course Code:	CSC323
Credit Hours:	2
Pre-requisite:	Theory of Automata

Course Objectives

In this course, students will be introduced to the overall structure of a compiler along with significant commonly employed relevant techniques. Students are expected to develop an understanding of the process of identifying the tokens of a programming language, construction of regular expressions to define tokens, and the construction of finite state automata to recognize tokens. Students will examine the process of Top-Down and Bottom-up parsing to construct an efficient parser. Students will also be able to understand the process of semantic analysis and different code generation schemes.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the basic techniques used in compiler construction such as lexical analysis, top-down, bottom-up parsing, context-sensitive analysis, and intermediate code generation.	1	C2
2. **Explain** the basic data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, and stack machines etc.	2	C2
3. **Design** and **implement** a compiler using a software engineering approach.	4	C3
4. **Select** and employ appropriate code generation and optimization techniques.	5	C4

Course Contents

Introduction to interpreter and compiler. Compiler techniques and methodology; Organization of compilers, Phases of compiler, Lexical and syntax analysis; Parsing techniques. Types of parsers; top- down parsing, Recursive decent parser, Context free grammar, left factoring, Left Recursion, Ambiguity, Backus norm form, Extended Backus norm form, Operator Associativity and Precedence Predictive parser or LL (1) parser, bottom-up parsing, Shift reduce parser, LR (0) parser, SLR parser, LALR parser. Semantic analyzer, Type checking, Scope symbol table, Syntax directed translation and definition. Intermediate code generation; Polish notation, Three address code, Quadruple, triples and indirect triples. Translation of Array. Optimization, peephole optimization, Semantic-Preserving Transformations, Algebraic Simplification, Copy Propagation, Code Motion, Dead Code Elimination, Common Subexpression Elimination (Local), Common Subexpression Elimination (Global). Target code generation; Assembly language, detection, and recovery from errors.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)			✓	
PLO5 (Modern Tool Usage)				✓
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Compilers: Principles, Techniques, and Tools, A. V. Aho, R. Sethi and J. D. Ullman, Addison- Wesley, 2nd ed., 2006
2. Modern Compiler Design, D. Grune, H. E. Bal, C. J. H. Jacobs, K. G. Langendoen, John Wiley, 2003.
3. Modern Compiler Implementation in C, A. W. Appel, M. Ginsburg, Cambridge University Press, 2004.

COMPILER CONSTRUCTION LAB	
Course Code:	CSL323
Credit Hours:	1
Pre-requisite:	Theory of Automata

Course Objectives

In this lab, students will implement the key components of a compiler allowing them to develop an understanding of the process of identifying the tokens of a programming language, construction of regular expressions to define tokens, and the construction of finite state automata to recognize tokens. Students will examine the process of Top-Down and Bottom-up parsing to construct an efficient parser. Students will also be able to understand the process of semantic analysis and different code generation schemes.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Apply various techniques to implement the lexical module, symbol table and syntax analyzer of a compiler.	2	P3
2. Implement different code generation techniques.	2	P3
3. Demonstrate the ability to design and implement a simple simulation of a compiler.	4	P4

Course Contents

Introduction to Compiler techniques and methodology; Organization of compilers, Phases of compiler. Revision of Computer programming and Data structure Concepts; Arrays, Structures, Pointers, Enumerations, Recursion, Functions, Trees. Lexical Phase; Tokens generation, Single and double operation implementation, Digit [0-9], alphabets [Aa-Zz] and keyword [if, do, while, main, int, struct etc.] scanners, symbol table. syntax analysis; Parsing techniques. Types of parsers; top-down parsing, Recursive decent parser, Context free grammar, left factoring, Left Recursion, Ambiguity, Backus norm form, Extended Backus norm form, Operator Associativity and Precedence implementation. Intermediate code generation; Operator Associativity and Precedence, C++ Statements, Tree Implementation, Tree traversal, Expression Evaluation. Target code generation; Assembly language, detection, and recovery from errors.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓	✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Compilers: Principles, Techniques, and Tools, A. V. Aho, R. Sethi and J. D. Ullman, Addison- Wesley, 2nd ed., 2006
2. Modern Compiler Design, D. Grune, H. E. Bal, C. J. H. Jacobs, K. G. Langendoen, John Wiley, 2003.
3. Modern Compiler Implementation in C, A. W. Appel, M. Ginsburg, Cambridge University Press, 2004.

DESIGN AND ANALYSIS OF ALGORITHMS	
Course Code:	CSC321
Credit Hours:	3
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The key objectives of this course include:

1. To learn techniques for the efficiency analysis of algorithms.
2. To study most commonly used algorithm design techniques.
3. To discuss design and efficiency of specific algorithms for different computational problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Demonstrate** an understanding of algorithm design process and different problem-solving techniques.	2	C2
2. **Analyze** the time and space complexity of different algorithms.	3	C4
3. **Design** algorithms to solve simple computational problems and compare the implementations empirically.	4	C6

Course Contents

Introduction, Role of algorithms in computing; Analysis of algorithms, Asymptotic notations: Big-O, Big Ω, Big Θ, Introduction to complexity classes; Recursive algorithms and recurrence relations; Sorting Algorithms; Graph algorithms; Algorithm Design Techniques: Brute Force, Divide-and-conquer, Transform-and-conquer, Greedy approach, Dynamic Programming and Backtracking; Optimization problems: Matrix multiplication, Closest pair, String matching, Shortest path, Traveling salesperson, N- Queens, Sum of subsets and Knapsack problem.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Harsh Bhasin, Algorithms: Design and Analysis (2015), Oxford University Press.
2. Anany V. Levitin, Introduction to the Design and Analysis of Algorithms (Third Edition), 2012,
   Pearson Education.
3. Cormen, Leiserson, Rivest and Stein (CLRS), Introduction to Algorithms (Third Edition), 2009, McGraw Hill.

LINEAR ALGEBRA

Course Code:	GSC121
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course aims to familiarize the students with the basic concepts of linear algebra, thorough understanding of matrix operations, vector spaces, linear transformations eigen values and eigen vectors and diagonalizations. Furthermore, the course also aims at enhancing students' ability to reason Mathematically and enable them to apply this knowledge to other fields in of Computer Science.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Interpret** the fundamental concepts of linear algebra, vector equations and linear transformations.	1	C2
2. **Apply** the basic knowledge of vector spaces, eigen value and eigen vectors to solve the critical problems of Linear Algebra.	2	C3
3. **Solve** systems of linear equations appearing in different engineering applications.	3	C3

Course Contents

Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms, Applications of linear systems.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Elementary Linear Algebra by Howard Anton
2. Linear Algebra and its Applications by Gibert Strang

ISLAMIC STUDIES

Course Code:	ISL101
Credit Hours:	2
Pre-requisite:	None

Course Objectives

This course is aimed to enhance understanding of students regarding concepts of faith and ehkam, ahadees and sunnah and compare with modern day living. It is also focused to enhance understanding of the students regarding Islamic Ethics, laws, culture, civilization, and contemporary issues. Moreover, to enhance the skills of students for understanding Islamic Architecture, its forms, styles, elements and an introduction to Muslim Architects

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of fundamental human rights and relation with non-Muslims through discussion on related issues	9	C2
2. **Demonstrate** knowledge of Islamic civilization and moral values	10	C2

Course Contents

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam, Introduction to Quranic Studies, Basic Concepts of Quran, History of Quran, Uloom-ul –Quran, Basic Quranic Teachings of Faith related to Surah Baqarah Verse 284-286, Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11), Faith on the Day of Judgment with Verses of Surah AlHashar (18,19,20) Related to Day of Judgment, Seerah of Holy Prophet (S.A.W)-I, Important Events with Lessons Derived from the life of Holy Prophet in Makkah, Basic Quranic Teachings of Adab-e-Nabi relate to Surah Al-ahzab, Seerah of Holy Prophet (S.A.W) – II, Important Events with Lessons Derived from the life of Holy Prophet (S.A.W) in Madina, Quranic Teachings of Adab Al-Nabi related to Surah Al Hujrat Verse 1-3, Introduction to Hadith, Basic Concepts of Hadith, History of Hadith, Kinds of Hadith

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2
PLO1 (Academic Education)		
PLO2 (Knowledge for Solving Computing Problems)		
PLO3 (Problem Analysis)		
PLO4 (Design/Development of Solutions)		
PLO5 (Modern Tool Usage)		
PLO6 (Individual and Teamwork)		
PLO7 (Communication)		
PLO8 (Computing Professionalism and Society)		
PLO9 (Ethics)	✓	
PLO10 (Life-long Learning)		✓

Resources

1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

ARTIFICIAL INTELLIGENCE

Course Code:	CSC325
Credit Hours:	3
Pre-requisite:	Object Oriented Programming

Course Objectives

The key objectives of this course include:

1. To get the historical perspective and foundation of artificial intelligence.
2. To learn the applications and trends of artificial intelligence.
3. To get familiarity with basic artificial intelligent techniques for problem solving, decision making, knowledge representation, inference, planning and learning.
4. Investigate applications of AI techniques in intelligent agents, expert systems and machine learning models.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** key components of artificial intelligence.	1	C2
2. **Implement** classical artificial intelligence techniques for problem solving.	2	C2
3. **Appraise** real world problems for machine learning based solutions	3	C4
4. **Apply** knowledge representation and inference techniques for practical problem solving.	4	C3

Course Contents

Introduction (Introduction, basic component of AI, Identifying AI systems, branches of AI, etc.); Problem Solving by Searching (Informed searching, Uninformed searching, Local searching.); Constraint Satisfaction Problems; Adversarial Search (Min-max algorithm, Alpha beta pruning, Game-playing); Reasoning and Knowledge Representation (Introduction to Reasoning and Knowledge Representation, Propositional Logic, First order Logic);Learning (Unsupervised learning, Supervised learning, Reinforcement learning) ;Uncertainty handling (Uncertainty in AI, Fuzzy logic); Recent trends in AI and applications of AI algorithms (trends, Case study of AI systems, Analysis of AI systems)

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Russell, S. and Norvig, P. “Artificial Intelligence. A Modern Approach”, 4th ed, Prentice Hall, Inc., 2020.
2. Luger, G.F. and Stubblefield, W.A., 2009. AI algorithms, data structures, and idioms in Prolog, Lisp, and Java. Pearson Addison-Wesley
3. Artificial Intelligence: The Basics, Kevin Warwick, Routledge, 2013

ARTIFICIAL INTELLIGENCE LAB

Course Code:	CSL325
Credit Hours:	1
Pre-requisite:	Object Oriented Programming

Course Objectives

The key objectives of this course include:

- To learn basic program constructs of AI development tool, such as an AI language (Python) & expert system shell (Prolog).
- To learn basics of intelligent agents and their environment.
- To learn implementation of search algorithm with their real world perspective.
- To learn concepts of knowledge based systems: representation and reasoning.
- To implement basic machine learning models.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** proficiency in developing AI applications in python and Prolog	5	P3
2. **Apply** basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation and reasoning	2	C3
3. **Demonstrate** proficiency in developing and applying models of machine learning	4	C3

Course Contents

The course includes the introduction and then building the proficiency in the python programming language and prolog for understanding and experimenting the AI techniques. The course includes the understanding and experience of the language variables, expressions, operands and operators, loops, control structures, debugging, error messages, functions, strings, lists, basic graphics and some libraries in the language. Python & Prolog programming languages will be used to explore and illustrate various techniques in Artificial Intelligence towards Knowledge Based Systems, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, adversarial searching) and machine Learning.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)	✓		
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Russell, S. and Norvig, P. “Artificial Intelligence. A Modern Approach”, 4th ed, Prentice Hall, Inc., 2020.
2. Denis Rothman , “Artificial Intelligence By Example “, 2nd Edition, 2020
3. Ivan Bratko, “Prolog Programming for Artificial Intelligence?, 4th edition, Pearson Addison- Wesley, 2012
4. Dennis Merritt , Expert Systems in Prolog, springer , 2017

NUMERICAL ANALYSIS

Course Code:	GSC320
Credit Hours:	3
Pre-requisite:	Differential Equations

Course Objectives

The primary objective of this course is to develop the basic understanding of the construction of numerical algorithms. This course will help students in building of numerical algorithms to estimate the solutions to common problems in science. The emphasis of the course will be the thorough study of numerical algorithms to understand the accuracy that various methods provide, the efficiency and precision for large scale systems, and issues of stability of methods.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate the understanding of common numerical methods.	1	C2
2. Apply typical numerical approaches, errors, to compute approximate solutions to Mathematical problems.	2	C3
3. Evaluate numerical methods for a variety of Mathematical processes and problems, including integration and differentiation.	3	C5
4. Develop numerical methods using a programming language.	2	C6

Course Contents

Mathematical preliminaries and error analysis, round-off errors and computer arithmetic, Calculate Divided Differences. Use Divided-difference Table. Find Newton's Interpolation Polynomial. Calculate Interpolation with Equally Spaced Data. Find the Difference Table. Calculate, Newton's Forward & Backward Difference Formulae. Use Gauss Formulae. Use Stirling's Interpolation Formula. Use Bessel's Interpolation Formula. Use Everett's Interpolation Formula. Solve Nonlinear Equations. Solve Equations by Bisection Method. Solve Equations by Regula Falsi Method. Solve Equations by Secant Method. Solve Equations by Newton-Raphson Method. Find Fixed Point Iteration. Solve Equations by Jacobi Iterative Methods. Solve Equations by Gauss Seidel Method Calculate Numerical Differentiation. Find Numerical Differentiation Formulae Based on Equally Spaced Data. Find Numerical Differentiation Based on Newton's Forward Differences. Find Numerical Differentiation Based on Newton's Backward Differences. Find Numerical Differentiation Based on Stirling's Formula. Find Numerical Differentiation Based on Bessel's Formula. Find Numerical Differentiation Based on Lagrange's Formula. Calculate Error Analysis of Differentiation Formulae. Solve Richardson Extrapolation. Calculate Numerical Integration. Use Trapezoidal Rule with Error Term. Use Simpson's 1/3 Rule with Error Term. Use Simpson's 3/8 Rule with Error Term. Use Composite Numerical Integration. Use Composite Trapezoidal Rule. Use Composite Simpson's Rule. Find Richardson's Extrapolation. Find Newton-Cotes Closed Quadrature Formulae.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		✓
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Numerical Analysis (9th Edition) by Richard L. Burden, J. Douglas Faires
2. Numerical Methods for Scientific Computing by J.H. Heinbockel

TECHNICAL WRITING AND PRESENTATION SKILLS

Course Code:	HSS320
Credit Hours:	3
Pre-requisite:	Communication Skills

Course Objectives

The main objective of this course is to develop effective writing and presentation skills in students. After learning effective data gathering, interpreting and presentation skills, students will be able to write clear, persuasive, and accessible documents for intended audiences. Furthermore, this course aims to develop textual, linguistic and presentation competencies in students appropriate for their professional careers.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Demonstrate an appropriate communication style to different types of audiences in an ethically responsible manner.	9	A2
2. Demonstrate competence in producing technical documents.	7	A3
3. Work on a standard word processing software along with a referencing tool for writing technical reports.	5	P4
4. Present topics using modern presentation skills and demonstrate a thorough understanding of verbal and non-verbal communication.	7	A3

Course Contents

Introduction to Technical Writing: Definition & Scenarios, Importance Of Technical Writing, Teamwork, 21st-Century Business Management Philosophies, Conflict Resolution in Team Meeting, Strategies For Successful Collaboration, Producing the Product, The Writing Process: An Overview, Prewriting, Writing, Rewriting, The Process In Practice, Objectives in Technical Writing, Writing at Work: Clarity, Conciseness, Accuracy, Organization, Ethics, Audience Recognition and Involvement, Audience Recognition, Defining Terms for Different Audience Levels, Biased Language- Issues of Diversity, Multiculturalism, Research: Criteria for Writing Research Reports, Process, Plagiarism, The Summary: Criteria for Writing Summaries, Process, Process Log, Reports, Reports: Criteria For Writing Reports, Types Of Reports, Trip Report, Progress Report, Lab Report, Feasibility Report, Incident Report, Investigation Report, Meeting Minutes, Proposals:, Writing At Work, Criteria For Proposals, Process, Sample External and Internal Proposals, Oral Communication: Everyday Oral Communication, Telephone And Voice Mail, Informal Oral Presentations, Oral Communication, Formal Presentations, Parts Of a Formal Oral Presentation, Visual Aids, PowerPoint Presentations, The Writing Process, The Job Search: Objectives, How To Find Job Openings, Criteria For Effective Resumes, Methods Of Delivery, Sample Resumes, Criteria For Effective Letters Of Application, Techniques For Interviewing Effectively, Criteria For Effective Follow-Up Correspondence, Sample Follow-Up Letter, Checklists, Technical Description, Types Of Technical Description, Criteria For Writing Technical Descriptions:

Process, Process Log, Sample Technical Description, Instructions And User Manuals: Criteria For Writing Short Instructions, Process, Process Log, Sample Short Instructions.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)			✓	
PLO6 (Individual and Teamwork)				
PLO7 (Communication)		✓		✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)	✓			
PLO10 (Life-long Learning)				

Resources

1. Sharon J. Gerson, Steven M. Gerson ,"Technical Writing Process and Product", Fifth Edition
2. Diana G. Creep ,“Technical Writing principals, strategies, and readings", Fourth Edition
3. "Microsoft Manual of Style for Technical Publications", Microsoft Press, Third Edition
4. St. Martin's, Mike Marke ,"Technical Communication", Bedford, Eighth Edition

PARALLEL AND DISTRIBUTED COMPUTING

Course Code:	CEN455
Credit Hours:	3
Pre-requisite:	Operating Systems

Course Objectives

The key objectives of this course include familiarizing students with the core concepts of parallel and distributed computing, issues faced by distributed systems and their potential solutions to make distributed computing work. Students are also expected to be able to write computer programs for parallel and distributed architectures and analyze the performance of parallel programs.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of parallel and distributed computers.	1	C2
2. **Write** portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library.	4	C3
3. **Analyze** complex problems with shared memory programming with OpenMP.	3	C4

Course Contents

Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 2nd Edition, 2007
2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet, K Hwang, J Dongarra and GC. C. Fox, Elsevier, 1st Ed.

Pakistan studies

Course Code:	PAK101
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The course "Pakistan Studies" is aimed to impart knowledge about the reason of development, vision and history of Pakistan to the students. It will cover the era ranging from pre-development to the post-development of Pakistan and highlight the great sacrifices made by the leaders of the Islamic State Pakistan. This course will help students develop a sense of patriotism as well as an urge for creative reconstruction. It will seek to cover Pakistan's Cultural Heritage since ancient times, Muslim Political Thought over the centuries, Constitutional Development since 1947, Political Systems and their functioning, Public Policies and Reforms, Agro-Industrial Projects, Urbanization, Social change and Transformation, Political Development

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of political and constitutional system of Pakistan	8	C2
2. **Understand** the social, moral, and cultural values system of Pakistan.	9	C2
3. **Analyze** the contemporary problems faced by Pakistan (social, human resource, economic development, food safety / water resources)	8	C4
4. **Develop** an understanding and appreciation for patriotism and loyalty towards national interest.	10	C4

Course Contents

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal, Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Political and Constitutional development of Pakistan, Pakistan and its geopolitical dimension, Pakistan and International Affairs, Pakistan and the challenges ahead. Viable political order and the contemporary issues, social issues, environmental issues, economics disparity, attention required at the current local and global issues like global warming.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)	✓		✓	
PLO9 (Ethics)		✓		
PLO10 (Life-long Learning)				✓

Resources

1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976 3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

INFORMATION SECURITY

Course Code:	CSC407
Credit Hours:	3
Pre-requisite:	Data communication and Networking

Course Objectives

The objective of this course is to equip the students with the basic yet essential knowledge of the concepts of information security, confidently, integrity and availability, authentication models, IDS systems and cryptography techniques. By the end of this course, the students will be able to apply their knowledge of information security policy formation and enforcement in communication networks.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** key concepts of information security such as design principles, cryptography, risk management, and ethics.	2	C2
2. **Apply** various security and risk management tools for achieving information security and privacy.	5	C3
3. **Identify** appropriate techniques to tackle and solve problems in the discipline of information security.	3	C4
4. **Create** solutions to real life scenarios using different security related tools.	4	C6

Course Contents

Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓			
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)		✓		
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Cryptography and Network Security by William Stallings. Publisher: Pearson ,6th Edition (2012).
2. Computer Security Art and Science by Matt Bishop, Publisher: Addison-Wesley Professional; 2nd edition (2018).
3. Computer Security: Principles and Practice, 3rd edition by William Stallings
4. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
5. Computer Security, 3rd edition by Dieter Gollmann
6. Computer Security Fundamentals, 3rd edition by William Easttom

BS Artificial Intelligence

CURRICULUM DOCUMENT

DEPARTMENT OF COMPUTER SCIENCE, BAHRIA UNIVERSITY

Contents

Vision and Mission

Vision and Mission of Bahria University

Vision: To become a knowledge and creativity driven international university that contributes towards development of society.

Mission: To ensure academic excellence through deliverance of quality education and applied research in a collegiate environment having strong linkages with industry and international community to meet the societal challenges.

Vision of the Computer Science Department

To become a center of excellence in Computer Science education, research, and globalized technologies

Mission of the BS Artificial Intelligence program

To prepare graduates who can analyze, design, and develop effective AI solutions and contribute effectively towards society.

Program Educational Objectives (PEOs)

PEO-1: Utilize knowledge to solve real-world problems by applying theory, principles, and methods of computing in general and artificial intelligence in particular.

PEO-2: Demonstrate social and ethical responsibility in professional life.

PEO-3: Manifest lifelong learning for sustained professional and personal progression.

PEO-4: Practice effective communication and teamwork skills.

Program Learning Outcomes (PLOs)

PLO1 Academic Education: To prepare graduates as computing professionals.

PLO2 Knowledge for Solving Computing Problems: Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

PLO3 Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

PLO4 Design/ Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO5 Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

PLO6 Individual and Teamwork: Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

PLO7 Communication: Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

PLO8 Computing Professionalism and Society: Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

PLO9 Ethics: Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.

PLO10 Life-long Learning: Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Mapping of PLOs to PEOs

No.	Program Learning Outcomes (PLOs)	PEOs			
		PEO-1	PEO-2	PEO-3	PEO-4
1	Academic Education	✔		✔	
2	Knowledge for solving Computing Problems	✔		✔	
3	Problem Analysis	✔			
4	Design/ Development of Solutions	✔	✔		
5	Modern Tool Usage	✔		✔	
6	Individual and Teamwork				✔
7	Communication				✔
8	Computing Professionalism and Society		✔	✔	
9	Ethics		✔		
10	Life-long Learning	✔		✔	

Program Approval/Revision History

S No.	Description/Remarks	Approved by	Date
1.	Program Approval	36th ACM	
2.	Program Launch		Fall 2021
3.	Curriculum Revision		

Program Eligibility Criteria

Minimum 50% marks in Intermediate (HSSC) Examination (Pre-Medical/Pre-Engg.) or equivalent qualification with Mathematics certified by IBCC.

Deficiency: For Pre-Medical students, the following two deficiency courses of mathematics will be taught during the first year.

- Fundamentals of Mathematics I GSC 103 (3 Credit Hours)
- Fundamentals of Mathematics II GSC 104 (3 Credit Hours)

List of Courses

General Education Courses (19 credit hours)

Pre requisite	Course Code	Course Title	Lec	Lab	CR
None	ENG 105	Functional English	3	0	3
ENG 105	HSS 120	Communication Skills	3	0	3
HSS 120	HSS 320	Technical Writing & presentation skills	3	0	3
None	CSC 307	Professional Practices	3	0	3
None	CSC 114	Introduction to Information & Communication Technology	2	1	3
None	PAK 101	Pakistan Studies	2	0	2
None	ISL 101	Islamic Studies	2	0	2

Mathematics and Science Foundation Courses (12 credit hours)

Pre requisite	Course Code	Course Title	Lec	Lab	CR
None	GSC 110	Applied Calculus & Analytical Geometry	3	0	3
None	GSC 122	Probability & Statistics	3	0	3
None	GSC 121	Linear Algebra	3	0	3
GSC 110	GSC 210	Differential Equations	3	0	3

University Electives (12 credit hours)

Pre requisite	Course Code	Course Title	Lec	Lab	CR
Foreign Language Elective					
None	HSS 459	Foreign Language	3	0	3
Management Science Electives					
None	MGT 111	Principles of Management	3	0	3
None	MKT 110	Principles of Marketing	3	0	3
None	FIN 201	Fundamentals of Finance	3	0	3
None	MGT 242	Organizational Theory & Behavior	3	0	3
None	HSS 410	Entrepreneurship	3`	0	3
Social Science Electives					
None	HSS 107	Introduction to Psychology	3	0	3
None	HSS 202	Introduction to Sociology	3	0	3
None	HSS 115	Introduction to Media Studies	3	0	3
None	BES 103	Critical Thinking	3	0	3
Economics Electives					
None	HSS 410	Entrepreneurship	3	0	3
None	HSS 411	Engineering economics and management	3	0	3
None	ESCO 520	Economics	3	0	3

Computing Core Courses (39 credit hours)

Pre requisite	Course Code	Course Title	Lec	Lab	CR
None	CSC 113	Computer Programming	3	1	4
CSC 113	CSC 210	Object Oriented Programming	3	1	4
CSC 113	CSC 221	Data Structure & Algorithms	3	1	4
None	GSC 221	Discrete Mathematics	3	0	3
CSC 221	CSC 320	Operating Systems	3	1	4
None	CSC 220	Database Management Systems	3	1	4
None	SEN 220	Software Engineering	3	0	3
None	CEN 222	Data Communication and Networking	3	1	4
CEN 222	CSC 407	Information Security	3	0	3
None	ESC 498/499	Final Year Project	0	6	6

Computer Science Core Courses (18 credit hours)

Pre requisite	Course Code	Course Title	Lec	Lab	CR
CEN 120	CEN 324	Computer Organization and Assembly Language	3	1	4
GSC 113	CEN 120	Digital Logic Design	3	1	4
CSC 221	CSC 321	Design and Analysis of Algorithms	3	0	3
CSC 320	CEN 455	Parallel & Distributed Computing	3	0	3
CSC 210	AIC 201	Artificial Intelligence	3	1	4

Artificial Intelligence Core Courses (18 credit hours)

Pre requisite	Course Code	Course Title	Lec	Lab	CR
AIC 201	AIC 202	Programming for Artificial Intelligence	2	1	3
AIC 201	AIC 301	Machine Learning	2	1	3
AIC 201	AIC 303	Artificial Neural Networks	2	1	3
AIC 201	AIC 203	Knowledge Representation & Reasoning	3	0	3
None	AIC 304	Computer Vision	2	1	3
None	CSC 441	Natural Language Processing	3	0	0

Artificial Intelligence Electives (15 Credit hours)

Pre requisite	Course Code	Course Title	Lec	Lab	CR
GSC 122	AIC 305	Advance Statistics	3	0	3
	CSC 315	Theory of Automata	3	0	3
	CSC 452	Data Mining	3	0	3
	AIC 401	Deep learning	2	1	3
None	AIC 306	Speech Processing	3	0	3
None	AIC 402	Reinforcement Learning	3	0	3
	AIC 403	Fuzzy System	2	1	3
	AIC 307	Evolutionary computing	3	0	3
	AIC 308	Agent Based Modeling	3	0	3
	CEN 458	Robotics	3	0	3
	ITC 411	Cyber security	3	0	3

Program Roadmap

SEMESTER 1							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	None	GSC 110	Applied Calculus and Analytical Geometry	3	0	3	16
2.	None	CSC 114	Introduction to Information & Communication Technology	2	0	2	
3.	None	CSL 114	Introduction to Information & Communication Technology Lab	0	1	1	
4.	None	ENG 105	Functional English	3	0	3	
5.	None	CSC 113	Computer Programming	3	0	3	
6.	None	CSL 113	Computer Programming Lab	0	1	1	
7.	None	GSC 221	Discrete Mathematics	3	0	3	

SEMESTER 2							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	None	CEN 120	Digital Logic Design	3	0	3	18
2.	None	CEL 120	Digital Logic Design Lab	0	1	1	
3.	CSC 113	CSC 210	Object Oriented Programming	3	0	3	
4.	CSC 113	CSL 210	Object Oriented Programming Lab	0	1	1	
5.	None	CSC 220	Database Management Systems	3	0	3	
6.	None	CSL 220	Database Management Systems Lab	0	1	1	
7.	None	GSC 121	Linear Algebra	3	0	3	
8.	None	GSC 122	Probability and Statistics	3	0	3	

SEMESTER 3							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	GSC 110	GSC 210	Differential Equations	3	0	3	18
2.	None	CEN 222	Data Communication and Networking	3	0	3	
3.	None	CEL 222	Data Communication and Networking Lab	0	1	1	
4.	CSC 113	CSC 221	Data Structures and Algorithms	3	0	3	
5.	CSC 113	CSL 221	Data Structures and Algorithms Lab	0	1	1	
6.	CSC 210	AIC 201	Artificial Intelligence	3	0	3	
7.	CSC 210	AIL 201	Artificial Intelligence Lab	0	1	1	
8.	ENG 105	HSS 120	Communication Skills	3	0	3	

SEMESTER 4							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	CSC 221	CSC 320	Operating Systems	3	0	3	17
2.	CSC 221	CSL 320	Operating Systems Lab	0	1	1	
3.	CEN 120	CEN 325	Computer Organization& Assembly Language	3	0	3	
4.	CEN 120	CEL 325	Computer Organization& Assembly Language Lab	0	1	1	
5.	CSC 221	CSC 321	Design and Analysis of Algorithms	3	0	3	
6.	AIC 201	AIC 202	Programming for Artificial Intelligence	2	0	2	
7.	AIC 201	AIL 202	Programming for Artificial Intelligence Lab	0	1	1	
8.			University Elective 1	-	-	3	

SEMESTER 5							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	AIC 201	AIC 203	Knowledge Representation & Reasoning	3	0	3	18
2.	AIC 201	AIC 301	Machine Learning	2	0	2	
3.	AIC 201	AIL 301	Machine Learning Lab	0	1	1	
4.	CSC 320	CEN 302	Parallel & Distributed Computing	2	0	2	
5.	CSC 320	CEL 302	Parallel & Distributed Computing Lab	0	1	1	
6.	None	CSC 307	Professional Practices	3	0	3	
7.			Elective 1	-	-	3	
8.			University Elective 2	3	0	3	

SEMESTER 6							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	AIC 201	AIC 303	Artificial Neural Networks	2	0	2	17
2.	AIC 201	AIL 303	Artificial Neural Networks Lab	0	1	1	
3.	None	AIC 304	Computer Vision	2	0	2	
4.	None	AIL 304	Computer Vision Lab	0	1	1	
5.	None	CSC 441	Natural Language Processing	3	0	3	
6.		ISL 101	Islamic Studies/ Ethics	2	0	2	
7.			Elective 2	-	-	3	
8.			University Elective 3	3	0	3	

SEMESTER 7							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	None	ESC 498	Project I	0	3	3	14
2.	None	SEN 220	Software Engineering	3	0	3	
3.	HSS 120	HSS 320	Technical Writing & Presentation Skills	3	0	3	
5.		PAK 101	Pakistan Studies	2	0	2	
			Elective 3	-	-	3	

SEMESTER 8							
S No.	Pre-Req	Course Code	Course Title	Theory	Lab	CR	CR/Sem
1.	None	ESC 499	Project II	0	3	3	15
2.	CEN 222	CSC 407	Information Security	3	0	3	
3.			University Elective 4	-	-	3	
4.			Elective 4	-	-	3	
			Elective 5	-	-	3	
						Total:	133

APPLIED CALCULUS & ANALYTICAL GEOMETRY

Course Code:	GSC110
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The main aim of this course is to introduce students with the fundamental concepts of calculus and analytical geometry. In addition to understanding of concepts, one of the key goals is to enable students to apply the learned concepts to solve various practical problems. The course will serve to help the Computer Science students to understand and solve the problems involving Mathematical and logical concepts in other courses and problem domains.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
Describe real value functions of one and more variables	1	C1
Apply the concepts of limits and continuity to solve problems in differential calculus	3	C3
Solve applied problems by applying concepts of Integration	3	C3

Course Contents

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normal lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)		✓	✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Calculus and Analytic Geometry by Kenneth W. Thomas.
2. Calculus by Stewart, James.
3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole.

INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGY	
Course Code:	CSC110
Credit Hours:	2
Pre-requisite:	None

Course Objectives

The objectives of this course include making the students learn the fundamental concepts of computing technologies and enable them to apply the concepts of number systems, programming, and databases. Furthermore, understanding networking and internet technologies also makes part of this course.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Describe** the components of a computer system	1	C1
2. **Understand** the fundamentals of operating systems, databases, and number systems	2	C2
3. **Explain** Networking and Internet Technologies	2	C2

Course Contents

Basic Definitions and Concepts, Hardware: Computer Systems and Components. Storage Devices, Number Systems. Software: Operating Systems, Programming and Application Software, Introduction to Programming, Databases and Information Systems, Networks, Data Communication, The Internet, Browsers and Search Engines, The Internet: Email, Collaborative Computing and Social Networking, The Internet: E-Commerce, IT Security, and other issues: Ad hoc networks, Introduction to cloud computing and virtualization.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	✓
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Livesley, Robert Kenneth (2017) An introduction to automatic digital computers. Cambridge University Press.
2. June P & Dan O (2015), New Perspective on Computer, 16/e, Cengage Learning.
3. Charles S. Parker, (2014) Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
4. Deborah (2013), Understanding Computers, 14/e, Cengage Learning.
5. Gary B (2012), Discovering Computers, 1/e, South Western.
6. Peter Norton (2011), Introduction to Computers, 7 /e, McGraw-Hill

INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGY LAB	
Course Code:	CSL110
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The objectives of this course include making the students familiar with computer hardware and software and introduce them to common computer applications. Students will learn basic skills of different computer applications, apply concept of designing simple web pages and databases and implement the basic networks using different network topologies.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Observe** the operations of various components of computing system	1	P1
2. **Practice** the basic computer application software like MS Word, MS Excel, MS Power Point, MS Access etc.	5	P3
3. **Demonstrate** the use of communication and networking	6	P4

Course Contents

The basics of Computer Science will be covered in the ICT lab. This lab is designed to teach the skills needed to become proficient with the basic primary Microsoft applications: Excel, PowerPoint, Access and Word, basics of Web Programing: Basic HTML and how to create basic networks using different network topologies

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Livesley, Robert Kenneth (2017) An introduction to automatic digital computers. Cambridge University Press.
2. June P & Dan O (2015), New Perspective on Computer, 16/e, Cengage Learning.
3. Charles S. Parker, (2014) Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
4. Deborah (2013), Understanding Computers, 14/e, Cengage Learning.
5. Gary B (2012), Discovering Computers, 1/e, South Western.
6. Peter Norton (2011), Introduction to Computers, 7 /e, McGraw-Hill

FUNCTIONAL ENGLISH

Course Code:	ENG105
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course incorporates four Basic English language skills – reading, writing, speaking and listening, with chief emphasis on class participation resulting in both written and verbal responses.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Demonstrate English listening skills to function successfully in target language listening situation.	7	A1
2. Exhibit English reading skills to comprehend various aspects of the nature of the reading material.	7	A1
3. Practice English speaking skills to express effectively through speech.	7	A2
4. Demonstrate formal and informal English writing skills to express ideas and convey message to target readers.	7	C3

Course Contents

Basic English Composition, Introduction, Sentence and Structure, Components of a sentence, Types of Sentences, Subject verb agreement – Rules and common mistakes, The Reading Process, Skimming and scanning, reading for gist, Sample Reading Passages, How to look for contextual meanings, Types of readings, Looking for meaning, Writing a summary, Mechanics of writing, Brain storming and drafting, Writing a topic sentence and supporting details, Essays and types – basic, Basics of grammar in writing, Tenses, Reported speech, Verbs and types, The writing Process, Cohesion and coherence – introduction, Essays and types – basic, Story writing/ narrating an incident – structure and process, Common grammatical mistakes, Report Writing, Dialogue Writing, Oral Communication, Conversational Skills/Speaking, Presentation skills, Debate and speech, Agreements and disagreements, listening process, listening for specific information, Listening for gist, Basics of Grammar

– Grammar in Speech, Modifiers, Articles and determiners, Role Play, Phonetics and Phonology, Vowels and consonants, Stress and syllabification, Commonly mispronounced words, Sample audios and practice.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)	✓	✓	✓	✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342-1.
2. English Grammar in Use with Answers: A Self Study Reference and Practice Book by Raymond Murphy. Cambridge University Press, 2012.
3. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills.
   Third Impression 1992. ISBN 0 19 453402 2
4. Intermediate Listening Comprehension: Understanding and Recalling Spoken English by Patricial Dunkel and Phyllis L. Lim, Third Edition. ISBN 1 4130 1257 4.
5. College Writing Skills with Readings by John Langlan 9th Edition

COMPUTER PROGRAMMING

Course Code:	CSC113
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The main course objectives are:

- To familiarize students with basic structured programming concepts.
- To emphasize upon problem analysis, logic building and program development skills.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of the basic concepts of programming	2	C2
2. **Exhibit** logic building ability using basic programming concepts	3	C2
3. **Apply** programming concepts to model requirements and solve simple computing problems using a high-level programming language	4	C3

Course Contents

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Diane Zak, An Introduction to Programming with C++, Eighth Edition, Course Technology
2. Paul. Deitel and Harvey. Deitel. , C++ How To Program, Eight Edition, Pearson, International Edition,
3. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Que Publishing,
4. Behrouz A. Forouzan, Richard F. Gilberg, Computer Science – A Structured Approach using C++, Second Edition, Cengage Learning,
5. C. M. Aslam, T. A. Qureshi, Programming with C++ Object-Oriented Programming, First Edition, Polymer Books

COMPUTER PROGRAMMING-LAB

Course Code:	CSL113
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The main course objectives are:

- To practice basic structured programming concepts.
- To develop problem analysis, logic building, program design and debugging skills.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate the understanding of programing language syntax and its usage	2	P2
2. Apply basic programming structures for logic construction	3	P3
3. Translate the devised solutions into computer programs and test the implementation	5	P3

Course Contents

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			✓
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Diane Zak, An Introduction to Programming with C++, Eighth Edition, Course Technology
2. Paul. Deitel and Harvey. Deitel. , C++ How To Program, Eight Edition, Pearson, International Edition,
3. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Que Publishing,
4. Behrouz A. Forouzan, Richard F. Gilberg, Computer Science – A Structured Approach using C++, Second Edition, Cengage Learning,
5. C. M. Aslam, T. A. Qureshi, Programming with C++ Object-Oriented Programming, First Edition, Polymer Books

DISCETE MATHEMATICS

Course Code:	GSC221
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To provide students with a solid understanding of Discrete Mathematics.
2. To introduce students to the fundamental as well as advanced concepts of Set theory, Algorithms, Functions, Mathematical reasoning , Graph Theory, and Trees.
3. To enable students improve problem-solving skills of enumerating objects using combinatorial analysis.
4. To enable students learn about the abstract Mathematical structures used to represent discrete objects and relationships between these objects.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of the key concepts of Discrete Structures.	1	C2
2. **Relate** various discrete structures with different areas of Computer Science.	2	C2
3. **Apply** formal logic proofs and/or informal, but rigorous, logical reasoning to real world problems.	3	C3
4. **Develop** pseudocodes of algorithms for standard computing problems.	4	C3

Course Contents

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, euler graph, Hamiltonian path, rooted trees, traversals.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Discrete Mathematics and Its Applications by Kenneth H. Rosen
2. Discrete Mathematics with Applications by Susanna S. Epp
3. Discrete Mathematics by Richard Johnson Baugh
4. Discrete Mathematical Structures by Kolman, Busby & Ross
5. Discrete and Combinatorial Mathematics: An Applied Introduction by Ralph P. Grimaldi
6. Logic and Discrete Mathematics: A Computer Science Perspective by Winifred Grassman

DIGITAL LOGIC DESIGN

Course Code:	CEN120
Credit Hours:	3
Pre-requisite:	Applied Physics

Course Objectives

1. To understand fundamentals of Digital Logic Design, binary systems and digital systems
2. To understand the implementation of Boolean algebra and K-maps for simplification of digital logic circuits.
3. To understand combinational logic i.e., coders, decoders, multiplexers, de-multiplexers, adders etc.,
4. To get familiarization with different types of designs in sequential logic circuits i.e. FFs, Shift registers counters through state machines etc.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understanding** of the Boolean Algebra, Boolean Functions, Combinational and Sequential Logic and PLDs	1	C2
2. **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques	2	C3
3. **Understand** the relationship between abstract logic characterizations and practical electrical implementations.	3	C2

Course Contents

Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Digital Logic Design by Morris Mano, Michale D. Ciletti 5rd edition Publisher Pearson Copy Right 2015.
2. Digital Fundamentals by Thomas L. Floyd, 10th edition, Publisher: Pearson 2015
3. Digital Electronics : An Introduction To Theory And Practice by William Gothmann H, 2011
4. Digital Electronics by John Morris, 2012

DIGITAL LOGIC DESIGN LAB

Course Code:	CEL120
Credit Hours:	1
Pre-requisite:	Applied Physics

Course Objectives

1. To Identify and work with number systems and codes.
2. To Understand logic gates, combinational circuits, Boolean Algebra, and simplification by using Karnaugh maps.
3. To Design and understand the working of simple logic circuits like comparator, adders, encoder, decoders, multiplexers and de-multiplexers.
4. To Understand the working of latches, flip flops, synchronous and asynchronous counters, clocks, shift registers.
5. To Understand memory structure and basic operations.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the tools and techniques for the design of digital electronic circuits	1	C2
2. **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques	2	P3
3. **Apply** the acquired knowledge to simulate and implement small-scale digital circuits	3	P4

Course Contents

Implementation of**:** AND,OR NAND ,NOR and NOT gates, simple circuits from given expression, gates using universal gates, parity generator with checker, half adder and full adder, multiplexer using gates , decoder using basic gates ,adder and subtractor using Integrated circuits.SR latches & SR latches with control bit, D Latch & D Flip Flops, SR Flip Flop, JK Flip Flop, Toggle Flip Flop.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Digital Logic Design by Morris Mano, 5th Edition, Publisher: Pearson, 2013
2. Digital Fundamentals by Thomas L. Floyd, 10th edition, Publisher: Pearson 2011
3. Digital Electronics : An Introduction To Theory And Practice by William Gothmann H, 2011
4. Digital Electronics by John Morris, 2012

OBJECT ORIENTED PROGRAMMING

Course Code:	CSC210
Credit Hours:	3
Pre-requisite:	Computer Programming

Course Objectives

The key objectives of this course include:

1. To understand the differences between traditional procedural design and object-oriented design
2. To provide a clear understanding of object-oriented concepts and their implementation
3. To analyse a problem from the perspective of the object oriented paradigm
4. To design and implement object oriented solutions to given problems

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Develop an understanding** of the underlying concepts of object-oriented paradigm	1	C2
2. **Apply** object-oriented concepts in solving computing problems	2	C3
3. **Design and implement** object-oriented solutions for small real-world problems	4	C4

Course Contents

Program design technique, Procedural vs. Object oriented Programming, Principles of Object-oriented Programming, Data Abstraction, Encapsulation, Classes and Objects, Function and Operator Overloading, Single and Multiple Inheritance, Polymorphism and Abstract Classess, Exception Handling, Stream I/O and File Processing, Class Templates.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. C++ How to Program, by Deitel & Deitel, 10th Edition, 2017, Pearson.
2. Matt Weisfeld (2018), The Object-Oriented Thought Process, 4th Edition, Wiley.
3. Joyce Farrell (2019), An Object-Oriented Approach to Programming Logic and Design, 5th Edition Hall, Course Technology.

OBJECT ORIENTED PROGRAMMING LAB

Course Code:	CSL210
Credit Hours:	1
Pre-requisite:	Computer Programming

Course Objectives

The key objectives of this course include:

1. To provide basic understanding of the tool used for the implementation of object-oriented concepts.
2. To practice the implementation of object-oriented concepts using a programming language
3. To design and implement object-oriented programs for computational problems.
4. To test and debug object-oriented programs.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate an understanding of object-oriented design concepts and their mapping to object-oriented programming	4	P3
2. Implement and debug object-oriented solutions for problems involving multiple classes	5	P4
3. Demonstrate effective communication and teamwork	6	A2

Course Contents

Program design technique, Procedural vs. Object oriented Programming, Basic Principles of Object- oriented Programming, Data Abstraction, Encapsulation, Classes and Objects, Function and Operator Overloading, Single and Multiple Inheritance, Polymorphism and Abstract Classes, Exception Handling, Stream I/O and File Processing, Class Templates.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)	✓		
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. C++ How to Program, by Deitel & Deitel, 10th Edition, 2017, Pearson.
2. Matt Weisfeld (2018), The Object-Oriented Thought Process, 4th Edition, Wiley.
3. Joyce Farrell (2019), An Object-Oriented Approach to Programming Logic and Design, 5th Edition Hall, Course Technology.)

DATABASE MANAGEMENT SYSTEMS	
Course Code:	CSC 220
Credit Hours:	3
Pre-requisite:	None

Course Objectives

They key objectives of this course include:

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
- To understand and use data manipulation language to query, update, and manage a database.
- To develop an understanding of essential DBMS concepts such as: database security, integrity, and concurrency.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** the fundamental concepts of databases	2	C2
2. **Apply** different database models to design conceptual, logical, and physical databases	4	C3
3. **Apply** queries to extract information from databases	5	C3
4. **Analyze** user requirements to design a database for the given scenarios	4	C4

Course Contents

Basic database concepts, Database approach vs. file-based system, Database architecture, Three level schema architecture, Data independence, Relational data model, Attributes, schemas, tuples, domains, relation instances, keys of relations, Integrity constraints, Relational algebra, selection, projection, Cartesian product, Types of joins, Normalization, functional dependencies, normal forms , Entity relationship model, entity sets, attributes , Relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub- queries in SQL, Grouping and aggregation in SQL , Concurrency control, Database backup and recovery, Indexes, NoSQL systems.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓			
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)		✓		✓
PLO5 (Modern Tool Usage)			✓	
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom
3. Database System Concepts, 7th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke

DATABASE MANAGEMENT SYSTEMS LAB	
Course Code:	CSL 220
Credit Hours:	1
Pre-requisite:	None

Course Objectives

Students successfully completing this course should be able:

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
- To understand and use data manipulation language to query, update, and manage a database.
- To develop an understanding of essential DBMS concepts such as: database security, integrity, and concurrency.
- To familiarize with the concepts of distributed database, and intelligent database, Client/Server (Database Server), data warehousing and data mining.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Practice** writing SQL commands to perform different tasks	4	P3
2. **Make** ER diagrams as to analyze and interpret data design of database	3	P4
3. **Make** a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS	5	P4

Course Contents

- Introduction to DBMS, SQL, Installation of tool, and interaction with tool.
- Overview of The SQL Query Language, Database Design, Data retrieval Language, Query Processing.
- Basic Query Structure, Conditional Queries Additional Basic Operations
- Data Definition Language
- Data Manipulation Language
- Set operations and Aggregate functions.
- SQL Case Study
- Entity Relationship Diagram and Relational Database Design, Entity Relationship Model
- Design Process, Modeling Constraints, E-R Diagram

- Group By, Having, Order By
- Views
- Sub-queries
- JOINS, Self-Join, Left Outer Join, Inner Join, Full Outer Join
- Application Design and Development Using .Net framework, Microsoft Visual Studio
- Transactions and Concurrency, Backup and Recovery

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)	✓		
PLO5 (Modern Tool Usage)			✓
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Database System Concepts, Sixth Edition. Avi Silberschatz, Henry F. Korth, S. Sudarshan.
   McGraw-Hill, 2010. ISBN 0-07-352332-1
2. Modern Database Management by Fred McFadden, Jeffrey Hoofer, Mary Prescott, Prentice Hall; 11th Edition (July 26, 2012). ISBN-10: 0132662256
3. Fundamentals of Database Systems by R. Elmasri and S. Navathe. 6th Edition, Addison-Wesley (2010). ISBN-10: 0136086209.

LINEAR ALGEBRA	
Course Code:	GSC121
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course aims to familiarize the students with the basic concepts of linear algebra, thorough understanding of matrix operations, vector spaces, linear transformations eigen values and eigen vectors and diagonalizations. Furthermore, the course also aims at enhancing students' ability to reason Mathematically and enable them to apply this knowledge to other fields in of Computer Science.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Interpret** the fundamental concepts of linear algebra, vector equations and linear transformations.	1	C2
2. **Apply** the basic knowledge of vector spaces, eigen value and eigen vectors to solve the critical problems of Linear Algebra.	2	C3
3. **Solve** systems of linear equations appearing in different engineering applications.	3	C3

Course Contents

Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms, Applications of linear systems.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Elementary Linear Algebra by Howard Anton
2. Linear Algebra and its Applications by Gibert Strang

PROBABILITY & STATISTICS	
Course Code:	GSC122
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To familiarize students with various statistical concepts and methods and enable them to develop statistical reasoning.
2. To understand and apply the concepts of Probability theory.
3. To provide students, the knowledge of different Probability distributions and their applications in Computer Science.
4. To enable the students to learn and apply the tools for curve fitting via Linear Regression and Correlation.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** and **express** the basic understanding of probability and statistics.	1	C2
2. **Demonstrate** an ability to use descriptive techniques to describe the statistical data.	2	C2
3. **Apply** inferential statistical methods to solve problems.	3	C3
4. **Analyze** and investigate any given data distribution.	3	C4

Course Contents

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two- Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	✓
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson.
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 4TH edition.
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill.

DIFFERENTIAL EQUATIONS

Course Code:	GSC210
Credit Hours:	3
Pre-requisite:	Applied Calculus and Analytical Geometry

Course Objectives

1. Enable students to recognize the appropriate Mathematical tools and techniques of differential equations which provide a logical approach to resolve wide variety of problems.
2. Carry out appropriate Mathematical manipulations by using techniques of differential equations to solve the application problems.
3. Interpret the significance of the Mathematical results.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Comprehend** the fundamental concepts of differential equations.	1	C2
2. **Apply** different methods of solving 1^{st} and 2^{nd} order ordinary differential equations.	2	C3
3. **Solve** Partial derivatives in different coordinate systems.	2	C3
4. **Analyze** and subsequently solve physical situations whose behavior can be described by ordinary/partial differential equations.	3	C4

Course Contents

Ordinary Differential Equations of the First Order: Geometrical Considerations, Isoclines, Separable Equations, Equations Reducible to Separable Form, Exact Differential Equations, Integrating Factors, Linear First-Order Differential Equations, variation of Parameters. Ordinary Linear Differential Equations; Homogeneous Linear Equations of the Second Order, Homogeneous Second-Order Equations with Constant Coefficients, General Solution, Real Roots, Complex Roots, Double Root of the Characteristic Equation, Differential Operators, Cauchy Equation, Homogeneous Linear Equations of Arbitrary Order, Homogeneous Linear Equations of Arbitrary Order with Constant Coefficients, Non- homogeneous Linear Equations. Modelling of Electrical Circuits. Systems of Differential Equations. Series Solutions of Differential Equations. Partial Differential Equations: Method of Separation of variables, wave, Heat & Laplace equations and their solutions.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓	✓	
PLO3 (Problem Analysis)				✓
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Advanced Engineering Mathematics Michael, G.1996, Prentice Hall Publishers.
2. Advanced Engineering Mathematics, 7th edition, Erwin, K. 1993, John Wiley & Sons Inc.
3. A First Course in Differential Equation Zill. Prindle. Weber. Schmidt.1996. Brooks/Cole Publishing.
4. Differential Equations with Boundary-Value Problems, Dennis. G. Zill, Michael, R. Cullen. 1996, Brooks/Cole Publishing,
5. Elementary Differential Equations with Applications C. H. Edwards. David, E. 1993. Penney, Prentice Hall.

DATA COMMUNICATION & NETWORKING	
Course Code:	CEN222
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To give understanding of the concepts related to Data Communication & Networks
2. To provide the detailed insight into the layered structure of OSI and TCP/IP Models.
3. To enable to apply knowledge of Data Communication & Networks and layered models in analysis, problem solving and developing small and medium scale networks**.**

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** basic principles and functionalities of Data Communication and Networks.	1	C2
2. **Explain** the services and functions provided by each layer in the Internet protocol stack.	2	C2
3. **Identify** various internetworking devices and protocols, and their functions in a network.	2	C3

Course Contents

Network Models: Communication Model, Layered Protocol Architecture, OSI Reference Model, TCP/IP Architecture. **Physical Layer and Media**: Data and Signals, Digital Transmission, Analog Transmission**,** Bandwidth Utilization: Multiplexing**,** Switching**, Data Link Layer:** Error Detection and Correction, Data Link Control, Multiple Access, Ethernet, LAN and VLAN. Network Layer: Logical Addressing, Internet Protocol, IP Packet (IPv4), IP Addressing and Routing: IP Classes and Subnetting, Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Internet Control Message Protocol (ICMP), Internet Group Management Protocol (IGMP). **Routing Algorithms:** Link State Routing, Distance Vector Routing, Address Mapping, Error Reporting and Multicasting, Delivery, forwarding and routing. **Transport Layer:** Process to Process Delivery: UDP, TCP and SCTP, Congestion Control. **Application Layer:** Domain Name System (DNS), Electronic Mail and File Transfer, WWW and HTTP.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	✓
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Behrouz A. Forouzan, "TCP/IP Protocol Suite", McGraw-Hill. (Latest Edition)
2. A. Leon-Garcia, "Communication Networks", McGraw-Hill. (Latest Edition)
3. William Stallings, "Data and Computer Communication", Prentice Hall. (8th Edition)

DATA COMMUNICATION & NETWORKING LAB	
Course Code:	CEL222
Credit Hours:	1
Pre-requisite:	None

Course Objectives

This is a basic level lab course emphasizing on the network design and configuration of devices in a network. This lab familiarizes students with IP addressing, its classes and classless IP addressing technique, configurations of Switches and Routers and application of different switching and routing protocols. At the end of the course, students are expected to be able to design, analyze and simulate medium-sized networks.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Make** different cable types.	1	P2
2. **Apply** and simulate different routing protocols like RIP, OSPF, NAT and ACL.	5	P3
3. **Build** Computer Network (s) on various topologies.	6	P3

Course Contents

- Basic cable construction and testing (straight, cross-over)
- Introduction to Packet Tracer and building and testing a Peer-to-Peer network physically and on packet Tracer.
- Introduction to Switch and Router & their Command Line Interface (CLI) fundamentals.
- Establishing a console session with CISCO Router 3900 Series Using HyperTerminal, retrieving configurations from NVRAM and TFTP server and configuring DHCP.
- Building and testing a Router based network using Static Routing.
- Building and testing VLAN and Inter-VLAN in switch domain network.
- Configuring RIP between routers.
- Configuring Access Control Lists (ACLs) on a Router.
- Configuring OSPF and Mutli-area OSPF between routers.
- Configuring Network Address Translation (NAT) on a Router.
- Configuring Wired LANS and WLANs in Wireshark Packet Analyzer.
- Configuring IoTs in Packet Tracer
- Configuring DSL and VoIP in Packet Tracer.
- Open-Ended Lab

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

Tools

- Packet Tracer 7.2
- Wireshark Network Analyzer 2.6.0
- Hyper Terminal
- Cisco Switch 2600 series
- Cisco Router 3900 series

DATA STRUCTURES AND ALGORITHMS	
Course Code:	CSC221
Credit Hours:	3
Pre-requisite:	Computer Programming

Course Objectives

The primary objective of the course is to help students understand the importance of data structures and well-designed algorithms for efficient management of computing resources while programming. Popularly employed linear and nonlinear data structures are described from the perspective of their specification, application, and implementation. Several sorting and searching techniques are also discussed to help students design efficient solutions for real life problems. Basic knowledge of algorithm's complexity analysis is also provided for identification of time costly processes**.**

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** and **compare** different data structures and their applications	1	C2
2. **Apply** appropriate data structures according to the given scenarios and application domain.	2	C3
3. **Analyze** time complexity of different algorithms	2	C4
4. **Design** efficient algorithm(s) to solve real-world problems	4	C6

Course Contents

Abstract Data Types (ADTs) , Linear data structures (Stacks, Queues, Linked list), Non-linear data structures (Trees, Graphs), Recursion and recursive algorithms, Sorting Algorithms (Bubble, Insertion, Selection, Quick, Merge, Shell, Heap), Searching (Linear, Binary, Depth First, Breadth First, Shortest Path, Minimum Spanning Trees), Hashing and Collision resolution techniques (Open Addressing, Separate Chaining, Double Hashing), Data Compression (Huffman's Code), Complexity Analysis of Algorithms (Big-O notation)

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓	✓	
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss, 7th Edition, Published by Addison-Wesley, 2019.
2. Data Structures and Algorithms in C++, by Drozdek Adam, 6th Edition, 2020
3. Data Structures and Algorithms using C & C++, Augenstein & Tenenbaum, 2019.
4. C++ Plus Data Structures, 7th Edition, Nell Dale, Jones and Bartlett Learning, 2020.
5. Data Structures using C++, Varsha H. Patil, 6th Edition, Oxford University Press, 2018.

DATA STRUCTURES & ALGORITHMS LAB	
Course Code:	CSL221
Credit Hours:	1
Pre-requisite:	Computer Programming

Course Objectives

This lab is aimed at implementing common linear and nonlinear data structures, sorting techniques, and hashing algorithms to solve various programming tasks with efficiency.
The primary objectives of the course include the following.

1. Implement efficient data structures for real world problem solving.
2. Design & implement various operations on commonly used linear/non-linear data structures.
3. To employ efficient techniques for searching and sorting data.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Implement different linear and non-linear data structures	3	P3
2. Construct programs for problems and application domain by using appropriate data structures.	4	P4
3. Demonstrate effective teamwork in solving problems	6	A2

Course Contents

The key concepts covered in the course include basics of data structures and abstract data types, algorithms, linear data structures: stacks, queues, linked lists and variants, non-linear data structures: trees, heaps and graphs, operations on data structures, sorting algorithms, hashing and complexity analysis of algorithms.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)	✓		
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss, 7th Edition, Published by Addison-Wesley, 2019.
2. Data Structures and Algorithms in C++, by Drozdek Adam, 6th Edition, 2020
3. Data Structures and Algorithms using C & C++, Augenstein & Tenenbaum, 2019.
4. C++ Plus Data Structures, 7th Edition, Nell Dale, Jones and Bartlett Learning, 2020.
5. Data Structures using C++, Varsha H. Patil, 6th Edition, Oxford University Press, 2018

ARTIFICIAL INTELLIGENCE

Course Code:	AIC201
Credit Hours:	3
Pre-requisite:	Object Oriented Programming

Course Objectives

The key objectives of this course include:

- To introduce students with the historical perspective and foundation of Artificial Intelligence.
- To familiarize students with the applications and trends of Artificial Intelligence.
- To understand the basic Artificial Intelligence techniques for problem solving, decision making, knowledge representation, inference, planning and learning.
- To investigate applications of AI techniques in intelligent agents, expert systems, and machine learning models.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** different types of problem-solving artificial agents.	1	C2
2. **Apply** various artificial intelligence techniques for solving real world problems.	2	C3
3. **Analyze** the given problem(s) to select and apply the appropriate techniques of artificial intelligence.	3	C4

Course Contents

An Introduction to Artificial Intelligence and its applications (History of AI, case studies of classical AI systems, types of AI, categorization of AI systems); Problem formulation and Solving by Searching (Informed searching, Uninformed searching, Iterative improvement algorithms , deterministic and non- deterministic adversarial search); constraint satisfaction Problem and their solutions; Introduction to Knowledge Based Systems, Reasoning and Knowledge Representation; Intelligent planning; Probabilistic reasoning; Decision making; Introduction to Learning from examples; Introduction to cognitive computing and its relation to artificial intelligence, Recent trends in AI and applications of AI algorithms. Ethics, philosophy, safety and future trends in artificial intelligence

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Russell, S. and Norvig, P. “Artificial Intelligence. A Modern Approach”, 4th ed, Prentice Hall, Inc., 2020.
2. Denis Rothman , “Artificial Intelligence By Example “, 2nd Edition, 2020
3. Luger, G.F. and Stubblefield, W.A., “AI algorithms, data structures, and idioms in Prolog, Lisp, and Java”, Pearson Addison-Wesley. 2009.
4. Ivan Bratko, “Prolog Programming for Artificial Intelligence?, 4th edition, Pearson Addison- Wesley, 2012
5. Norvig, P., “Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp”, Morgan Kaufman Publishers, Inc., 1992.
6. Dennis Merritt , Expert Systems in Prolog, springer , 2017

ARTIFICIAL INTELLIGENCE LAB

Course Code:	AIL201
Credit Hours:	1
Pre-requisite:	Object Oriented Programming

Course Objectives

The key objectives of this course include:

- To learn basic program constructs of AI development tool, such as an AI language (LISP) & expert system shell (Prolog).
- To learn basics of intelligent agents and their environment.
- To implement of search algorithm with their real-world perspective.
- To familiarize with the concepts of knowledge-based systems: representation and reasoning.
- To implement basic machine learning models.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** proficiency in developing AI applications in LISP and Prolog	5	P2
2. **Apply** basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning	2	P3
3. **Develop** and apply models of machine learning	4	P3

Course Contents

The course includes the introduction and then building the proficiency in the LISP programming language and prolog for understanding and experimenting the AI techniques. The course includes the understanding and experience of the language symbols, variables, functions, expressions, operators and lists.

LISP & Prolog programming languages will be used to explore and illustrate various techniques in Artificial Intelligence towards Knowledge Based Systems, Problem Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, adversarial searching) and machine Learning.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)	✓		
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 4th ed, Prentice Hall, Inc., 2020.
2. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2009.
3. Ivan Bratko, "Prolog Programming for Artificial Intelligence?, 4th edition, Pearson Addison- Wesley, 2012
4. Norvig, P., "Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp", Morgan Kaufman Publishers, Inc., 1992.
5. Dennis Merritt , Expert Systems in Prolog, springer , 2017

COMMUNICATION SKILLS

Course Code:	HSS120
Credit Hours:	3
Pre-requisite:	Functional English

Course Objectives

The general focus of the course is on clarifying and broadening the students' understanding of verbal and written English by comparing what they already know. The aim is to provide the students with a course that focuses on their needs as learners of English in the present day. Accordingly, the emphasis will be on the communicative use of contemporary English for practical purposes. The course will, therefore, provide material not only to extend the students' general language proficiency, but also to systematically develop their abilities to use English as a tool for study and to prepare them for their future careers.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Participate actively in group discussions by exercising attentive listening and constructive debate.	6	A2
2. Initiate a conversation and communicate effectively by employing intermediate-to advanced level English vocabulary.	7	A3
3. Express or present ideas independently in front of an audience and effectively respond to queries.	7	A3
4. Write formal business letters by applying technical writing skills.	7	C3

Course Contents

Business Writing: Seven Cs of Communication, Business Writing Styles, Business Memos, Business Emails, Tenders and Quotations, Billing and Invoicing, Common Writing Errors, Useful Vocabulary and Phrases, Personal Documents, Oral Communication: Verbal and non-verbal communication, Conducting meetings, Small group communication, Taking minutes, Presentation Skills: Presentation Strategies, Defining the Objective, scope and audience of the presentation, Material gathering and material organization strategies, Time management, Opening and concluding, Use of Visual audio- visual aids, Delivery and presentation, Activities Involved: Interactive session of students for communication skills followed by assessment with defined rubrics.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)	✓			
PLO7 (Communication)		✓	✓	✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Anchor in English-II (Lessons 1-5), A SPELT Publication
2. Christopher Fry, "Summary Writing (Book-I)", Oxford University Press
3. College Essays by John Langlan
4. Barron's TOFFLiBT Edition
5. Communication Skills for Engineers by Sunita Marshal and C.Muralikrishna
6. Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342
7. Practical English Grammar Exercises 1 by A. J. Thomson and A. V. Martinet. Third edition. Oxford University Press. ISBN 978-0-19-431349-0.
8. A Practical Guide to Business Writing: Writing in English for Non-Native Speakers by Khaled Mohamed Al Maskari. Wiley. ISBN 978 1 118 41079 0

OPERATING SYSTEMS

Course Code:	CSC320
Credit Hours:	3
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The key objectives of this course include enabling the students to understand the basic components of a computer operating system, and the interactions among the various components. The course will also cover the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	1	C2
2. **Apply** the concepts of memory management, I/O management CPU management and processor management etc.	2	C3
3. **Analyze** the algorithms of the core functions of Operating Systems and explain the major performance issues with respect to the core functions.	3	C4

Course Contents

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

OPERATING SYSTEMS LAB	
Course Code:	CSL320
Credit Hours:	1
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The Operating Systems lab aims to enable students different key concepts of Operating Systems. Students will apply system software and tools available in modern operating systems to develop a deeper understanding of the underlying concepts. The labs will also cover the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Implement OS concepts like those of shell scripting, processes, file manipulation and inter-processes communication.	3	P2
2. Demonstrate the knowledge in applying system software and tools available in modern operating systems.	5	P4

Course Contents

Introduction to Operating Systems, Linux Operating System, Introduction and configuration of the Virtual Machine, VMware tools Installation, Ubuntu Installation, Understanding utility Linux Commands, File Commands, Filter and pipes, Introduction to Shell programming, Common Shells, keywords, Shell variables and their types, Metacharacters, Arithmetic operators and expressions, single and multiple user inputs, Positional Parameters in Shell programming, Different types of operators and expressions, Conditional statements, Nested Conditional statements (if-else, switch case), file testing, execution of shell script, Scripts for automation a process e.g. copying contents of one file to another. Command substitution in scripts, Process Creation through fork system call, Sleep Command, Inter-processes Communication, System calls, Implementation of Filing through System calls, CPU scheduling, Multi-Threading, sharing of variables between two or more threads, Synchronization to avoid deadlock, Using Semaphore, Implementation of Synchronization between multiple threads, Signal handling.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2
PLO1 (Academic Education)		
PLO2 (Knowledge for Solving Computing Problems)		
PLO3 (Problem Analysis)	✓	
PLO4 (Design/Development of Solutions)		
PLO5 (Modern Tool Usage)		✓
PLO6 (Individual and Teamwork)		
PLO7 (Communication)		
PLO8 (Computing Professionalism and Society)		
PLO9 (Ethics)		
PLO10 (Life-long Learning)		

Resources

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE

Course Code:	CEN325
Credit Hours:	3
Pre-requisite:	Digital Logic Design

Course Objectives

1. To introduce the organization of computer systems and usage of assembly language for optimization and control.
2. To expose the low-level logic employed for problem solving while using assembly language as a tool.
3. To familiarize with Assembly Language, directives, macros , operators , and program structures.
4. To learn programming methodology to be able to create system level software tools.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Identify** the major components of computer architecture, and explain their purposes and interactions	1	C2
2. **Simulate** the internal representation of data, and show how data is stored and accessed in, I/O modules, and the interconnecting components of the computer systems	2	C3
3. **Analyze** the relationships between hardware architecture and its instruction set.	3	C4

Course Contents

Basics of computer architecture and low-level programming, i.e., assembly code and hardware manipulation. The basic concepts of computer architecture and machine instructions. Memory access and storage; Instruction execution. Assembly language. Computer organization; Data representation and transfer. Digital arithmetic, Memory storage and addressing methods, Procedures and interrupts, Conditional processing.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Modern X86 Assembly Language Programming: Covers x86 64-bit, AVX AVX2 and AVX-512 (2nd Edition), Daniel Kusswurm December 6, 2018.
2. Assembly Language Programming & Architecture (ARM books, Band 1)12. August 2016.
3. Intel Microprocessors 8086 8088 -Architecture, Programming, and Interfacing (8th Edition) 2014.

COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE LAB	
Course Code:	CEL325
Credit Hours:	1
Pre-requisite:	Digital Logic Design

Course Objectives

The objectives of this lab include:

1. Familiarizing with Assembly Language directives, macros, operators, and program structures
2. Learning Programming methodology to be able to create system level software tools and application programs.
3. Understanding of interrelationship between hardware and software.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Acquire** the basic knowledge of computer organization, computer architecture and assembly language	2	C2
2. **Implement** the arithmetic logical operation using Instruction set architecture (ISA) at ALU & memory units	3	P3
3. **Solve** the problems related to computer organization and assembly language	3	P4

Course Contents

The basics of computer architecture and low-level programming, i.e., assembly code and hardware manipulation. Basic concepts of computer architecture and machine instructions, Memory access and storage, Instruction execution, Data representation and transfer, Digital arithmetic, Memory storage and addressing methods, Procedures and interrupts, Conditional processing.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Modern X86 Assembly Language Programming: Covers x86 64-bit, AVX AVX2 and AVX-512 (2nd Edition), Daniel Kusswurm December 6, 2018.
2. Assembly Language Programming & Architecture (ARM books, Band 1)12. August 2016.
3. Intel Microprocessors 8086 8088 -Architecture, Programming, and Interfacing (8th Edition) 2014.

DESIGN AND ANALYSIS OF ALGORITHMS	
Course Code:	CSC321
Credit Hours:	3
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The key objectives of this course include:

1. To learn techniques for the efficiency analysis of algorithms.
2. To study most commonly used algorithm design techniques.
3. To discuss design and efficiency of specific algorithms for different computational problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of algorithm design process and different problem-solving techniques.	2	C2
2. **Analyze** the time and space complexity of different algorithms.	3	C4
3. **Design** algorithms to solve simple computational problems and compare the implementations empirically.	4	C6

Course Contents

Introduction, Role of algorithms in computing; Analysis of algorithms, Asymptotic notations: Big-O, Big Ω, Big Θ, Introduction to complexity classes; Recursive algorithms and recurrence relations; Sorting Algorithms; Graph algorithms; Algorithm Design Techniques: Brute Force, Divide-and-conquer, Transform-and-conquer, Greedy approach, Dynamic Programming and Backtracking; Optimization problems: Matrix multiplication, Closest pair, String matching, Shortest path, Traveling salesperson, N- Queens, Sum of subsets and Knapsack problem.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Harsh Bhasin, Algorithms: Design and Analysis (2015), Oxford University Press.
2. Anany V. Levitin, Introduction to the Design and Analysis of Algorithms (Third Edition), 2012,
   Pearson Education.
3. Cormen, Leiserson, Rivest and Stein (CLRS), Introduction to Algorithms (Third Edition), 2009, McGraw Hill.

PROGRAMMING FOR ARTIFICIAL INTELLIGENCE

Course Code:	AIC202
Credit Hours:	2
Pre-requisite:	Artificial Intelligence

Course Objectives

This course aims to introduce standard programming practices and to help develop programming skills necessary for designing and implementing Artificial Intelligence systems. The course introduces a modern state of the art programming language for Artificial Intelligence, and builds up the necessary programming background for the main courses like Knowledge Representation & Reasoning, Machine Learning, Artificial Neural Networks, and Natural Language Processing. This course will help the students of Artificial Intelligence develop the programming acumen and style. The ultimate aim of this course is to help students in using the programming language to solve various problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Comprehend** the fundamental constructs of programming language for data analysis and representation.	2	C2
2. **Apply** the Object-oriented concepts in the programming language for data representation	2	C3
3. **Analyze** and solve programming and data analysis problems using standard libraries and/or toolboxes of the programming language.	4	C4

Course Contents

Introduction to Programming language (Python):

The first objective of the course is to introduce and then build the proficiency of students in the
programming language. The basics include IDE for the language (e.g., Jupyter Notebook or IPython), variables, expressions, operands and operators, loops, control structures, debugging, error messages, functions, strings, lists, object-oriented constructs and basic graphics in the language. Special emphasis is given to writing production quality clean code in the programming language using version control (git and subversion).

Introducing libraries/toolboxes necessary for data analysis:

The course should introduce some libraries necessary for interpreting, analyzing and plotting numerical data (e.g., NumPy, MatPlotLib, Anaconda and Pandas for Python) and give examples of each library using simple use cases and small case studies.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓	✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Severance, C.R., 2016. “Python for everybody: Exploring data using Python 3.” CreateSpace Independent Publ Platform.
2. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. “Python programming in context.” Jones & Bartlett Pub.
3. McKinney, W., 2012. “Python for data analysis: Data wrangling with Pandas, NumPy, and IPython.” O'Reilly Media, Inc.
4. Joshi, P., 2017. “Artificial intelligence with python.” Packt Publishing Ltd.
5. Janert, P.K., 2010. “Data analysis with open source tools: a hands-on guide for programmers and data scientists.” O'Reilly Media, Inc.

PROGRAMMING FOR ARTIFICIAL INTELLIGENCE LAB

Course Code:	AIL202
Credit Hours:	1
Pre-requisite:	Artificial Intelligence

Course Objectives

This lab aims to facilitate understanding of standard programming practices and to help develop programming skills necessary for designing and implementing Artificial Intelligence systems. The lab will help the students of Artificial Intelligence to develop the programming acumen and style. The ultimate goal of this lab is to help students in using the programming language to solve various problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Apply** the fundamental constructs of programming language for data analysis and representation.	2	P3
2. **Implement** programming and data analysis problems using standard libraries and/or toolboxes of the programming language.	5	P3
3. **Design** and implement a medium-sized project using suitable programming tools and techniques.	4	P4

Course Contents

Introduction to programming basics like IDE for the language (e.g., Jupyter Notebook or IPython), variables, expressions, operands and operators, loops, control structures, debugging, error messages, functions, strings, lists, object-oriented constructs and basic graphics in the language. Special emphasis is given to writing production quality clean code in the programming language using version control (git and subversion). Introduction to some libraries necessary for interpreting, analyzing and plotting numerical data (e.g., NumPy, MatPlotLib, Anaconda and Pandas for Python) by developing simple use cases and small case studies.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Severance, C.R., 2016. “Python for everybody: Exploring data using Python 3.” CreateSpace Independent Publ Platform.
2. Miller, B.N., Ranum, D.L. and Anderson, J., 2019. “Python programming in context.” Jones & Bartlett Pub.
3. McKinney, W., 2012. “Python for data analysis: Data wrangling with Pandas, NumPy, and IPython.” O'Reilly Media, Inc.
4. Joshi, P., 2017. “Artificial intelligence with python.” Packt Publishing Ltd.
   Janert, P.K., 2010. “Data analysis with open source tools: a hands-on guide for programmers and data scientists.” O'Reilly Media, Inc.

KNOWLEDGE REPRESENTATION AND REASONING	
Course Code:	AIC203
Credit Hours:	3
Pre-requisite:	Artificial Intelligence

Course Objectives

The key objectives of this course include:

- To understand the basics of knowledge-based systems.
- To learn different representation techniques such as propositional calculus, predicate calculus, horn clauses, description logic, semantic network, and ontologies.
- To develop and understanding of the concepts of rule-based reasoning.
- To learn concepts of representation and reasoning with uncertain knowledge.
- To understand the basics of fuzzy knowledge representation and reasoning.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the fundamentals of knowledge representation and reasoning in deterministic situations	2	C2
2. **Explain** the challenges in representing knowledge and reasoning under uncertainty	2	C2
3. **Develop** hybrid approaches by synergizing the existing frameworks to solve complex decision-making problems.	4	C3
4. **Analyze** given problems and apply appropriate knowledge representation frameworks.	3	C4

Course Contents

Introduction to knowledge based systems (basic concepts, components, application, history and current trends); *knowledge representation*: Propositional Logic, First-order Logic, Horn Clauses, Description Logic; *Reasoning*: categorization of reasoning, reasoning using Description Logic, Forward and Backward Chaining for reasoning; *Semantic Networks*: Ontologies and Ontology Languages; *Logical Agents*: Planning, Rule-based Knowledge Representation; *Reasoning Under Uncertainty*: Bayesian Networks Representation, Inference in Bayesian Networks; *Fuzzy knowledge representation and reasoning*: Fuzzy rules, Inference using Fuzzy Rules; Markov Model, Common-sense Reasoning, Explainable AI.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓	✓		
PLO3 (Problem Analysis)				✓
PLO4 (Design/Development of Solutions)			✓	
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (4^{th} Ed.), 2020)
2. Grega Jakus , Veljko Milutinović, Sanida Omerović, Sašo Tomažič , Concepts, Ontologies, and Knowledge Representation, springer, 2014
3. David Poole and Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, 2nd Ed, 2017
4. Ronald Brachman and Hector Levesque. Knowledge Representation and Reasoning, 2004

MACHINE LEARNING

Course Code:	AIC301
Credit Hours:	2
Pre-requisite:	Artificial Intelligence

Course Objectives

The key objectives of this course include:

- To develop and understanding of the basic machine learning concepts.
- To introduce different machine learning algorithms along with their strengths and weaknesses.
- To apply machine learning algorithms to solve problems of moderate complexity.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** and describe the basic concepts of machine learning	2	C2
2. **Apply** supervised learning techniques to solve classification problems	3	C3
3. **Apply** unsupervised techniques for different clustering tasks	3	C3
4. **Choose** and apply appropriate reinforcement learning algorithms to environments with complex dynamics.	4	C5

Course Contents

Introduction to machine learning; concept learning: General-to-specific ordering of hypotheses, Version spaces Algorithm, Candidate elimination algorithm; Supervised Learning: k-Nearest-neighbor algorithm ,decision trees, Naive Bayes, , Support Vector Machines, classifier evaluation metrics Over- fitting, noisy data, bias and variance,; Linear and Logistic regression; Unsupervised Learning: Hierarchical Clustering. Partitional clustering; Self-Organizing Maps (SOM); Semi-supervised learning with EM using labeled and unlabeled data; Reinforcement Learning: Hidden Markov models, Monte Carlo inference Exploration vs. Exploitation Trade-off, Markov Decision Processes; Ensemble Learning: Using committees of multiple hypotheses, bagging, boosting.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓			
PLO3 (Problem Analysis)		✓	✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Machine Learning, Tom, M., McGraw Hill, 1997.
2. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012.

MACHINE LEARNING LAB

Course Code:	AIL301
Credit Hours:	1
Pre-requisite:	Artificial Intelligence

Course Objectives

This lab is designed to facilitate students to comprehend the concepts learned during the Machine Learning course by means of practical implementations and analysis. Students would be able to apply machine learning algorithms to solve problems of moderate complexity.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Implement** supervised learning techniques to solve classification problems	5	P3
2. **Implement** unsupervised techniques for different clustering tasks	5	P3
3. **Design** and develop a medium-sized project using appropriate machine learning techniques	4	P4

Course Contents

Introduction to the basic tools, IDEs and libraries that are required for the implementation of machine learning algorithms. Implementation of feature representation, supervised learning algorithms: Decision Trees, Naïve Bayes, ANN, SVM, and evaluation metrics. Clustering techniques, regression techniques and reinforcement learning models.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)	✓	✓	
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Machine Learning, Tom, M., McGraw Hill, 1997.
2. Machine Learning: A Probabilistic Perspective, Kevin P. Murphy, MIT Press, 2012.

PARALLEL AND DISTRIBUTED COMPUTING

Course Code:	CEN302
Credit Hours:	2
Pre-requisite:	Operating Systems

Course Objectives

The key objectives of this course include familiarizing students with the core concepts of parallel and distributed computing, issues faced by distributed systems and their potential solutions to make distributed computing work. Students are also expected to be able to write computer programs for parallel and distributed architectures and analyze the performance of parallel programs.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of parallel and distributed computers.	1	C2
2. **Examine** parallel and distributed computing solutions for their pros and cons.	2	C4
3. **Analyze** complex problems with shared memory programming with OpenMP.	3	C4

Course Contents

Asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 2nd Edition, 2007
2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet, K Hwang, J Dongarra and GC. C. Fox, Elsevier, 1st Ed.

PARALLEL AND DISTRIBUTED COMPUTING LAB

Course Code:	CEL302
Credit Hours:	1
Pre-requisite:	Operating Systems

Course Objectives

The key objectives of this course include familiarizing students with the core concepts of parallel and distributed computing, issues faced by distributed systems and their potential solutions to make distributed computing work. Students are expected to be able to write computer programs for parallel and distributed architecture and analyze the performance of parallel systems. Students should be familiar with the implementation related concepts of Resource management, Load balancing, middleware, cluster and grid computing and Cloud computing.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** proficiency in shared-memory parallel programming with OpenMP.	2	P3
2. **Write** portable programs for parallel or distributed architectures using Message-Passing Interface (MPI) library.	3	P3
3. **Demonstrate** effective communication and teamwork.	6	A2

Course Contents

Implementation of Asynchronous/synchronous computation/communication, concurrency control and fault tolerance. Introduction to GPU programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms, parallel I/O, performance analysis and tuning, programming models, scheduling and synchronization.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 2nd Edition, 2007
2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet, K Hwang, J Dongarra and GC. C. Fox, Elsevier, 1st Ed.

PROFESSIONAL PRACTICES

Course Code:	CSC307
Credit Hours:	3
Pre-requisite:	None

Course Objectives

- To enhance key factors of interpersonal relations.
- To build social ethics.
- To know organizational behavior so that individual and team works can be done in a more professional way without compromising organization principles and without hurting others interests.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Identify the content of religious, national, or international law dealing with professional ethics	8	A2
2. Apply the knowledge of ethics in their personal and professional life	9	A3
3. Gain the ability to enhance key factors of interpersonal relations, to follow and implement the acquired knowledge of ethical skills in given situations by controlling his/her temperament.	10	A4

Course Contents

Computing Profession, Computing Ethics, Philosophy of Ethics. The Structure of Organizations, Finance and Accounting, Anatomy of a Software House, Computer Contracts, Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)	✓		
PLO9 (Ethics)		✓	
PLO10 (Life-long Learning)			✓

Resources

1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
2. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN10: 0131112414
3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
4. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN- 10: 0819193747

ARTIFICIAL NEURAL NETWORKS	
Course Code:	AIC303
Credit Hours:	2
Pre-requisite:	Artificial Intelligence

Course Objectives

This course will introduce Artificial Neural Networks, their basic architecture and how they mimic the human brain using simple mathematical models. Emphasis is made on the mathematical models, understanding learning laws, selecting activation functions and how to train the networks to solve classification problems. Students would be able to understand and use different types of neural networks and would be able to use different activation functions and construct layered networks to solve classification problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of the fundamentals of neural networks.	1	C2
2. **Apply** forward and backward pass on neural networks.	2	C3
3. **Differentiate** between different networks and their learning laws.	3	C4
4. **Design** an appropriate neural network to solve classification problems.	4	C6

Course Contents

Introduction and history of neural networks, Basic architecture of neural networks, Perceptron and Adaline (Minimum Error Learning) for classification, Multi-layer Perceptron, Algorithms for training of neural networks (such as Gradient Descent, ADAM, AdaGrad and RMS prop etc.), Hebbian, Neo- Hebbian and Differential Hebbian Learning, Drive Reinforcement Theory, Kohonen Self Organizing Maps, Associative memory, Bi-directional associative memory (BAM), Energy surfaces, The Boltzmann machines, Feedforward Networks; Backpropagation, Activation functions, Introduction to Deep learning and its architectures.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Neural Network Design, 2nd Edition, Martin T. Hagan, Howard, B. Demuth, Mark Hudson Beale and Orlando De Jesus, Publisher: Martin Hagan; 2 edition (September 1, 2014), ISBN-10: 0971732116
2. An Introduction to Neural Networks, James A Anderson, Publisher: A Bradford Book (March 16, 1995), ISBN-10: 0262011441
3. Fundamentals of Artificial Neural Networks, Mohammad Hassoun, Publisher: A Bradford Book (January 1, 2003), ISBN-10: 0262514672

ARTIFICIAL NEURAL NETWORKS LAB

Course Code:	AIL303
Credit Hours:	1
Pre-requisite:	Artificial Intelligence

Course Objectives

This lab is designed to facilitate students to comprehend the concepts learned during the Artificial Neural Networks course by means of practical implementations and analysis. Students would be able to understand and use different types of neural networks and would be able to use different activation functions and construct layered networks to solve classification problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Understand the fundamentals of neural networks from application perspective.	2	C2
2. Implement concepts of neural networks using modern tools and techniques.	5	P3
3. Design and implement ANNs to solve various classification problems.	4	P4

Course Contents

All labs are designed to complement the contents covered in the theory. Introduction to the basic tools, IDEs and libraries that are required for the implementation of neural networks. Hands-on practice of the fundamentals of neural networks like basic architecture on an ANN, hidden layers, perceptron, loss function and error estimation, and feed forward networks. Lab would also cover implementation of Back propagation, optimizers, Associative memory and Boltzmann machines.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Neural Network Design, 2nd Edition, Martin T. Hagan, Howard, B. Demuth, Mark Hudson Beale and Orlando De Jesus, Publisher: Martin Hagan; 2 edition (September 1, 2014), ISBN-10: 0971732116
2. An Introduction to Neural Networks, James A Anderson, Publisher: A Bradford Book (March 16, 1995), ISBN-10: 0262011441
3. Fundamentals of Artificial Neural Networks, Mohammad Hassoun, Publisher: A Bradford Book (January 1, 2003), ISBN-10: 0262514672

COMPUTER VISION

Course Code:	AIC304
Credit Hours:	2
Pre-requisite:	None

Course Objectives

This course is aimed at developing an understanding of the problems in simulating human perception into machines. Students will have a thorough understanding of the state-of-the-art computer vision methods, algorithms, and results. The students will also be able to apply the tools and techniques learned to solve practical vision related problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the basic concepts and methods in Computer Vision.	1	C2
2. **Apply** Computer Vision techniques to solve real world problems.	3	C3
3. **Compare** different algorithms for key tasks in Computer Vision like Object Detection and Image Segmentation.	2	C5

Course Contents

Introduction to Computer Vision and related areas along with applications, Image formation and representation: imaging geometry, digitization, cameras and projections, rigid and affine transformations, Camera Calibration, Image Filtering: Smoothing and Sharpening filters, Image Segmentation, Feature detection and matching: Edge detection, corner detection, line and curve detection, SIFT and HOG descriptors, Object detection and recognition using conventional as well as machine learning based methods, Deep learning-based object detectors and segmentation methods.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			✓
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Computer Vision: Algorithms and Applications, by Richard Szeliski.
2. Multiple View Geometry in Computer Vision, by Richard Hartley and Andrew Zisserman.
3. Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce.
4. Digital Image Processing, by Rafael Gonzalez and Richard Woods.

COMPUTER VISION LAB

Course Code:	AIL304
Credit Hours:	1
Pre-requisite:	None

Course Objectives

This course is aimed at developing an understanding of the problems in simulating human perception into machines. Through hands-on implementation, students are expected to develop a comprehensive understanding of the state-of-the-art computer vision methods, algorithms, and results. The students will also be able to apply the tools and techniques learned to solve practical vision related problems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Implement** the key concepts of computer vision (such as transformations, filtering etc.) using modern computer vision libraries.	5	P4
2. **Implement and compare** different image segmentation and object detection algorithms.	2	C5
3. **Design** and implement a complete computer vision-based solution to a real-world problem.	4	C6

Course Contents

Image transformations, Image Filtering: Smoothing and Sharpening filters, Image Segmentation, Feature detection and matching: Edge detection, corner detection, line and curve detection, SIFT and HOG descriptors, Deep learning-based object detectors R-CNN family, YOLO etc. Image segmentation using conventional and deep learning-based methods.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)	✓		
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Computer Vision: Algorithms and Applications, by Richard Szeliski.
2. Multiple View Geometry in Computer Vision, by Richard Hartley and Andrew Zisserman.
3. Computer Vision: A Modern Approach, by David Forsyth and Jean Ponce.
4. 4. Digital Image Processing, by Rafael Gonzalez and Richard Woods.

NATURAL LANGUAGE PROCESSING	
Course Code:	CSC441
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The course is aimed at providing students with leading trends and systems in natural language processing (NLP); making them understand the concepts of morphology, syntax, semantics and pragmatics of the language and that they are able to give the appropriate examples that will illustrate the NLP concepts; teaching them to recognize the significance of pragmatics for natural language understanding; enabling students to be capable to describe the application based on natural language processing and to show the points of syntactic, semantic and pragmatic processing.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of the techniques for information retrieval, language translation, and text classification.	1	C2
2. **Apply** classical and stochastic algorithms for parsing natural language.	2	C3
3. **Compare** and contrast deterministic and stochastic grammars and provide examples to show the adequacy of each.	2	C4
4. **Design** solutions to the given NLP problems like text classification or text summarization etc.	4	C6

Course Contents

Introduction & History of NLP, Parsing algorithms, Basic Text Processing, Minimum Edit Distance, Language Modeling, Spelling Correction, Text Classification, Deterministic and stochastic grammars, CFGs, Representing meaning /Semantics, Semantic roles, Semantics and Vector models, Sentiment Analysis, Temporal representations, Corpus-based methods, N-grams and HMMs, Smoothing and backoff, POS tagging and morphology, Information retrieval, Vector space model, Evaluation metrics, Information extraction, Relation Extraction (dependency, constituency grammar), Language translation, Text classification, categorization, Bag of words model, Question and Answering, Text Summarization.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓	✓	
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Daniel Jurafsky and James H. Martin. 2018. Speech and Language Processing: An Introduction to Natural Language Processing,. Third Edition. Prentice Hall
2. Foundations of Statistical Natural Language Processing, Manning and Schütze, MIT Press. Cambridge, MA: May 1999.

ISLAMIC STUDIES	
Course Code:	ISL101
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course is aimed to enhance understanding of students regarding concepts of faith and ehkam, ahadees and sunnah and compare with modern day living. It is also focused to enhance understanding of the students regarding Islamic Ethics, laws, culture, civilization, and contemporary issues. Moreover, to enhance the skills of students for understanding Islamic Architecture, its forms, styles, elements and an introduction to Muslim Architects

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of fundamental human rights and relation with non-Muslims through discussion on related issues	9	C2
2. **Demonstrate** knowledge of Islamic civilization and moral values	10	C2

Course Contents

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam, Introduction to Quranic Studies, Basic Concepts of Quran, History of Quran, Uloom-ul –Quran, Basic Quranic Teachings of Faith related to Surah Baqarah Verse 284-286, Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11), Faith on the Day of Judgment with Verses of Surah AlHashar (18,19,20) Related to Day of Judgment, Seerah of Holy Prophet (S.A.W)-I, Important Events with Lessons Derived from the life of Holy Prophet in Makkah, Basic Quranic Teachings of Adab-e-Nabi relate to Surah Al-ahzab, Seerah of Holy Prophet (S.A.W) – II, Important Events with Lessons Derived from the life of Holy Prophet (S.A.W) in Madina, Quranic Teachings of Adab Al-Nabi related to Surah Al Hujrat Verse 1-3, Introduction to Hadith, Basic Concepts of Hadith, History of Hadith, Kinds of Hadith

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**
PLO1 (Academic Education)		
PLO2 (Knowledge for Solving Computing Problems)		
PLO3 (Problem Analysis)		
PLO4 (Design/Development of Solutions)		
PLO5 (Modern Tool Usage)		
PLO6 (Individual and Teamwork)		
PLO7 (Communication)		
PLO8 (Computing Professionalism and Society)		
PLO9 (Ethics)	✓	
PLO10 (Life-long Learning)		✓

Resources

1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

SOFTWARE ENGINEERING

Course Code:	SEN220
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The objectives of this course include developing an understanding of Software Engineering and different software development paradigms. Comprehension of the importance of requirements and classifying the requirements and usage of UML in designing a Software also make part of the key objectives. The course also aims to equip the students with the skills required to construct quality software, which is reliable, reasonably easy to understand, modify and maintain.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Describe** various software engineering processes and activities	1	C1
2. **Apply** knowledge of software engineering appropriate to the discipline, particularly in the modeling, design, testing and deployment of software systems.	4	C3
3. **Analyze** and solve small-scale Software Engineering problems	3	C4

Course Contents

Introduction to Software & Software Engineering, Socio-Technical Systems, Emergent System Properties Legacy Systems, and Critical Systems, FAQs about Software Engineering, Professional and Ethical Responsibility, Key challenges in software engineering, Attributes of a quality software, Software Process Models: Process Activities, Plan Driven Models Coping with Change, Plan Driven Models (continued), Incremental Development Processes Spiral Model, Agile Software Development, Agile Processes Plan Driven and Agile development, Requirements Engineering: Functional & non -functional requirements, Requirements Specification Elicitation and Analysis, Requirements Validation, Requirements Engineering Process, System Modeling: Context Model, Interaction Model, Structural Model, Behavioral Model, Design and Implementation: OO, UML Introduction, UML Design Patterns, UML Design Patterns, Use case Introduction, Use case Diagrams, Activity Diagrams, Sequence Diagrams, Package Diagrams, Architectural Design Introduction, Architectural Design Decisions, Architectural Views and Patterns, Software Testing, Development Testing, Release Testing User Testing, Software Evolution

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Software Engineering, 9th Edition, Ian Somerville, Addison-Wesley, 2011
2. Software Engineering Modern Approaches, 2nd Edition, Eric J. Braude, Michel E. Bernstein, Wiley & Sons, INC, 2011
3. UML Distilled A Brief Guide to The Standard Object Modeling Language, by Martin Fowler
4. Object-Oriented Modeling and Design with UML by Michael R Blaha, James R Rumbaugh
5. Designing Flexible Object-Oriented Systems with UML by Charles Richter, Techmedia

TECHNICAL WRITING AND PRESENTATION SKILLS	
Course Code:	HSS320
Credit Hours:	3
Pre-requisite:	Communication Skills

Course Objectives

The main objective of this course is to develop effective writing and presentation skills in students. After learning effective data gathering, interpreting and presentation skills, students will be able to write clear, persuasive, and accessible documents for intended audiences. Furthermore, this course aims to develop textual, linguistic and presentation competencies in students appropriate for their professional careers.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Demonstrate an appropriate communication style to different types of audiences in an ethically responsible manner.	9	A2
2. Demonstrate competence in producing technical documents.	7	A3
3. Work on a standard word processing software along with a referencing tool for writing technical reports.	5	P4
4. Present topics using modern presentation skills and demonstrate a thorough understanding of verbal and non-verbal communication.	7	A3

Course Contents

Introduction to Technical Writing: Definition & Scenarios, Importance Of Technical Writing, Teamwork, 21st-Century Business Management Philosophies, Conflict Resolution in Team Meeting, Strategies For Successful Collaboration, Producing the Product, The Writing Process: An Overview, Prewriting, Writing, Rewriting, The Process In Practice, Objectives in Technical Writing, Writing at Work: Clarity, Conciseness, Accuracy, Organization, Ethics, Audience Recognition and Involvement, Audience Recognition, Defining Terms for Different Audience Levels, Biased Language- Issues of Diversity, Multiculturalism, Research: Criteria for Writing Research Reports, Process, Plagiarism, The Summary: Criteria for Writing Summaries, Process, Process Log, Reports, Reports: Criteria For Writing Reports, Types Of Reports, Trip Report, Progress Report, Lab Report, Feasibility Report, Incident Report, Investigation Report, Meeting Minutes, Proposals:, Writing At Work, Criteria For Proposals, Process, Sample External and Internal Proposals, Oral Communication: Everyday Oral Communication, Telephone And Voice Mail, Informal Oral Presentations, Oral Communication, Formal Presentations, Parts Of a Formal Oral Presentation, Visual Aids, PowerPoint Presentations, The Writing Process, The Job Search: Objectives, How To Find Job Openings, Criteria For Effective Resumes, Methods Of Delivery, Sample Resumes, Criteria For Effective Letters Of Application, Techniques For Interviewing Effectively, Criteria For Effective Follow-Up Correspondence, Sample Follow-Up Letter, Checklists, Technical Description, Types Of Technical Description, Criteria For Writing Technical Descriptions:

Process, Process Log, Sample Technical Description, Instructions And User Manuals: Criteria For Writing Short Instructions, Process, Process Log, Sample Short Instructions.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)			✓	
PLO6 (Individual and Teamwork)				
PLO7 (Communication)		✓		✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)	✓			
PLO10 (Life-long Learning)				

Resources

1. Sharon J. Gerson, Steven M. Gerson ,"Technical Writing Process and Product", Fifth Edition
2. Diana G. Creep ,“Technical Writing principals, strategies, and readings", Fourth Edition
3. "Microsoft Manual of Style for Technical Publications", Microsoft Press, Third Edition
4. St. Martin's, Mike Marke ,"Technical Communication", Bedford, Eighth Edition

Pakistan studies

Course Code:	PAK101
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The course "Pakistan Studies" is aimed to impart knowledge about the reason of development, vision and history of Pakistan to the students. It will cover the era ranging from pre-development to the post-development of Pakistan and highlight the great sacrifices made by the leaders of the Islamic State Pakistan. This course will help students develop a sense of patriotism as well as an urge for creative reconstruction. It will seek to cover Pakistan's Cultural Heritage since ancient times, Muslim Political Thought over the centuries, Constitutional Development since 1947, Political Systems and their functioning, Public Policies and Reforms, Agro-Industrial Projects, Urbanization, Social change and Transformation, Political Development

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of political and constitutional system of Pakistan	8	C2
2. **Understand** the social, moral, and cultural values system of Pakistan.	9	C2
3. **Analyze** the contemporary problems faced by Pakistan (social, human resource, economic development, food safety / water resources)	8	C4
4. **Develop** an understanding and appreciation for patriotism and loyalty towards national interest.	10	C4

Course Contents

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal, Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Political and Constitutional development of Pakistan, Pakistan and its geopolitical dimension, Pakistan and International Affairs, Pakistan and the challenges ahead. Viable political order and the contemporary issues, social issues, environmental issues, economics disparity, attention required at the current local and global issues like global warming.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)	✓		✓	
PLO9 (Ethics)		✓		
PLO10 (Life-long Learning)				✓

Resources

1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976 3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

INFORMATION SECURITY

Course Code:	CSC407
Credit Hours:	3
Pre-requisite:	Data Communication and Networking

Course Objectives

The objective of this course is to equip the students with the basic yet essential knowledge of the concepts of information security, confidently, integrity and availability, authentication models, IDS systems and cryptography techniques. By the end of this course, the students will be able to apply their knowledge of information security policy formation and enforcement in communication networks.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** key concepts of information security such as design principles, cryptography, risk management, and ethics.	2	C2
2. **Apply** various security and risk management tools for achieving information security and privacy.	5	C3
3. **Identify** appropriate techniques to tackle and solve problems in the discipline of information security.	3	C4
4. **Create** solutions to real life scenarios using different security related tools.	4	C6

Course Contents

Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓			
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)		✓		
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Cryptography and Network Security by William Stallings. Publisher: Pearson ,6th Edition (2012).
2. Computer Security Art and Science by Matt Bishop, Publisher: Addison-Wesley Professional; 2nd edition (2018).
3. Computer Security: Principles and Practice, 3rd edition by William Stallings
4. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
5. Computer Security, 3rd edition by Dieter Gollmann
6. Computer Security Fundamentals, 3rd edition by William Easttom

BS (IT) Curriculum

BS Information Technology

CURRICULUM DOCUMENT

DEPARTMENT OF COMPUTER SCIENCE, BAHRIA UNIVERSITY

Contents

Vision and Mission

Vision and Mission of Bahria University

Vision: To become a knowledge and creativity driven international university that contributes towards development of society.

Mission: To ensure academic excellence through deliverance of quality education and applied research in a collegiate environment having strong linkages with industry and international community to meet the societal challenges.

Vision of the Computer Science Department

To become a center of excellence in Computer Science education, research, and globalized technologies

Mission of the BS Information Technology program

To produce graduates having good problem solving and management skills and knowledge to generate IT solutions along with team building and professional skills.

Program Educational Objectives (PEOs)

PEO-1: Apply principles and practices of information technology and computing knowledge to solve challenging problems in relevant professions.

PEO-2: Demonstrate the ability to use modern tools learnt during degree program to design and develop effective solutions.

PEO-3: Practice communication skills as an individual or team player who possesses strong managerial and entrepreneurial abilities.

PEO-4: Function ethically and responsibly while making technical or managerial decisions to contribute effectively in profession and society.

Program Learning Outcomes (PLOs)

PLO1 Academic Education: To prepare graduates as computing professionals.

PLO2 Knowledge for Solving Computing Problems: Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the 16 abstraction and conceptualization of computing models from defined problems and requirements.

PLO3 Problem Analysis: Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

PLO4 Design/ Development of Solutions: Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO5 Modern Tool Usage: Create, select, adapt and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

PLO6 Individual and Teamwork: Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

PLO7 Communication: Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

PLO8 Computing Professionalism and Society: Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

PLO9 Ethics: Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.

PLO10 Life-long Learning: Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

Mapping of PLOs to PEOs

No.	Program Learning Outcomes (PLOs)	PEOs			
		PEO-1	PEO-2	PEO-3	PEO-4
1	Academic Education	✔			
2	Knowledge for solving Computing Problems	✔		✔	
3	Problem Analysis	✔		✔	
4	Design/ Development of Solutions		✔	✔	
5	Modern Tool Usage		✔		
6	Individual and Teamwork			✔	
7	Communication			✔	
8	Computing Professionalism and Society		✔	✔	✔
9	Ethics		✔		✔
10	Life-long Learning	✔			✔

Program Approval/Revision History

S No.	Description/Remarks	Approved by	Date
1.	Program Approval	22nd ACM	2014
2.	Program Launch		Fall 2014
3.	Curriculum Revision	27th ACM	2016
4.	Curriculum Revision	31st ACM	2018

Program Eligibility Criteria

Minimum 50% marks in Intermediate (HSSC) Examination (Pre-Medical/Pre-Engg.) or equivalent qualification with Mathematics certified by IBCC.

Note: For Pre-Medical students, the following two deficiency courses of 3 credit hours will be taught.

- Fundamentals of Mathematics I GSC 103 (3 Credit Hours)
- Fundamentals of Mathematics II GSC 104 (3 Credit Hours)

List of Courses

Computing Core Courses (39 credit hours)

Pre-requisite	Course Code	Course Title	Lec	Lab	CR
None	CSC 113	Computer Programming	3	1	4
CSC 113	CSC 210	Object Oriented Programming	3	1	4
CSC 113	CSC 221	Data Structure & Algorithms	3	1	4
None	GSC 221	Discrete Mathematics	3	0	3
CSC 221	CSC 320	Operating Systems	3	1	4
None	CSC 220	Database Management Systems	3	1	4
None	SEN 220	Software Engineering	3	0	3
None	CEN 222	Data Communication and Networking	3	1	4
CEN 222	CSC 407	Information Security	3	0	3
None	ESC 498	Final Year Project	0	6	6

General Education Courses (19 credit hours)

Pre-requisite	Course Code	Course Title	Lec	Lab	CR
None	ENG 105	Functional English	3	0	3
HSS 120	HSS 320	Technical Writing and Presentation Skills	3	0	3
ENG 105	HSS 120	Communication Skills	3	0	3
None	CSC 307	Professional Practices	3	0	3
None	CSC 114	Introduction to Information & Communication Technology	2	1	3
None	PAK 101	Pakistan Studies	2	0	2
None	ISL 101	Islamic Studies	2	0	2

Mathematics and Science Foundation Courses (12 credit hours)

Pre-requisite	Course Code	Course Title	Lec	Lab	CR
None	GSC 110	Applied Calculus & Analytical Geometry	3	0	3
None	GSC 122	Probability & Statistics	3	0	3
None	GSC 121	Linear Algebra	3	0	3
None	GSC 114	Applied Physics	2	1	3

University Electives (12 credit hours)

Pre-requisite	Course Code	Course Title	Lec	Lab	CR
Foreign Language Related					
None	HSS 459	Foreign Language	3	0	3
Management Related					
None	MGT 111	Principles of Management	3	0	3
None	MKT 110	Principles of Marketing	3	0	3
None	MGT 242	Organizational Theory & Behavior	3	0	3
None	HSS 410	Entrepreneurship	3	0	3
Social Science Related					
None	HSS 107	Introduction to Psychology	3	0	3
None	HSS 202	Introduction to Sociology	3	0	3
None	HSS 115	Introduction to Media Studies	3	0	3
None	BES 103	Critical Thinking	3	0	3
Economy Related					
None	ACC 101	Principles of accounting	3	0	3
None	ECO 110	Microeconomics – I	3	0	3
None	HSS 411	Engineering economics and management	3	0	3
None	ECO 520	Economics	3	0	3

IT Core Courses (24 credit hours)

Pre-requisite	Course Code	Course Title	Lec	Lab	CR
CEN 222	ITC 411	Cyber Security	3	0	3
CSC 220	ITC 424	Database Administration and Management	3	1	4
SEN 220	ITC 311	Information Technology Project Management	3	0	3
None	ITC 324	Information Technology Infrastructure	3	0	3
CEN 222	ITC 312	System and Network Administration	3	1	4
CSC 320	ITC 422	Virtual Systems and Services	3	1	4
None	ITC 226	Web System and Technologies	2	1	3

IT Support Courses (09 credit hours)

Pre-requisite	Course Code	Course Title	Lec	Lab	CR
CSC 220	ITC 321	Enterprise Systems	3	0	3
SEN 220	SEN 458	Software Requirement Engineering	3	0	3
GSC 114	CEN 122	Digital Design	2	1	3

List of Information Technology Elective Courses (18 credit hours)

Pre-requisite	Course code	Course Title	Lec	Lab	CR
CSC 210	CSC 313	Visual Programming	2	0	2
CSC 210	CSL 313	Visual Programming Lab	0	1	1
None	ITB 471	E-Commerce	3	0	3
None	ITC 425	Business Processing Re-engineering	3	0	3
None	ITC 457	Knowledge Management System & Technologies	3	0	3
CSC 220	CSC 452	Data Mining	3	0	3
CSC 220	CSC 454	Data Warehousing	3	0	3
GSC 221	CSC 411	Artificial Intelligence	2	0	2
GSC 221	CSL 411	Artificial Intelligence lab	0	1	1

ITC 226	SEN 421	Semantic Web	3	0	3
CSC 320	CSC 456	Distributed Computing	2	0	2
CSL 320	CSL 456	Distributed Computing Lab	0	1	1
None	CSC 486	Geographical Information System	2	0	2
None	CSL 486	Geographical Information System Lab	0	1	1
CSC 210	CSC 342	Parallel Programming	2	0	2
CSC 210	CSL 342	Parallel Programming lab	0	1	1
SEN 220	SEN 447	Software Testing	3	0	3
CSC 210	CSC 459	Client Server Programming	2	0	2
CSC 210	CSL 459	Client Server Programming Lab	0	1	1
None	CEN 445	Digital Image Processing	2	0	2
None	CEL 445	Digital Image Processing Lab	0	1	1
CSC 210	CSC 444	Computer Graphics	2	0	2
CSC 210	CSL 444	Computer Graphics Lab	0	1	1
CSC 220	CSC 468	Advanced Databases	2	0	2
CSC 220	CSL 468	Advanced Databases Lab	0	1	1
None	SEN 456	Usability Engineering	3	0	3
CSC 210	CSC 341	Mobile Application Development	2	0	2
CSC 210	CSL 341	Mobile Application Development Lab	1	0	1
None	CSC 426	Business Intelligence and Analytic	3	0	3
CSC 458	SEN 427	Information Systems Auditing and Assurance	3	0	3
None	SEN 428	Service Oriented Architecture	3	0	3
SEN 220	SEN 420	Software Quality Assurance	3	0	3

Program Roadmap

SEMESTER 1						
Pre-requisite	Course Code	Course Title	Theory	Lab	CR	CR/Sem
None	CSC 114	Introduction to Information & Communication Technology	2	0	2	16
None	CSL 114	Introduction to Information & Communication Technology Lab	0	1	1	
None	CSC 113	Computer Programming	3	0	3	
None	CSL 113	Computer Programming Lab	0	1	1	
None	ENG 105	Functional English	3	0	3	
None	GSC 110	Applied Calculus & Analytical Geometry	3	0	3	
None	GSC 114	Applied Physics	2	0	2	
None	GSL 114	Applied Physics Lab	0	1	1	

SEMESTER 2						
Pre-requisite	Course Code	Course Title	Theory	Lab	CR	CR/Sem
CSC 113	CSC 210	Object Oriented Programming	3	0	3	16
CSC 113	CSL 210	Object Oriented Programming Lab	0	1	1	
ENG 105	HSS 120	Communication Skills	3	0	3	
None	GSC 221	Discrete Mathematics	3	0	3	
GSC 114	CEN 122	Digital Design	2	0	2	
GSC 114	CEL 122	Digital Design Lab	0	1	1	
		University Elective 1	-	-	3	

SEMESTER 3						
Pre-requisite	Course Code	Course Title	Theory	Lab	CR	CR/Sem
CSC 113	CSC 221	Data Structures & Algorithms	3	0	3	17
CSC 113	CSL 221	Data Structure & Algorithms Lab	0	1	1	
None	CEN 222	Data Communication & Networking	3	0	3	
None	CEL 222	Data Communication & Networking Lab	0	1	1	
None	CSC 307	Professional Practices	3	0	3	
None	GSC 121	Linear Algebra	3	0	3	
None	GSC 122	Probability & Statistics	3	0	3	

SEMESTER 4						
Pre-requisite	Course Code	Course Title	Theory	Lab	CR	CR/Sem
CSC 221	CSC 320	Operating Systems	3	0	3	17
CSC 221	CSL 320	Operating Systems Lab	0	1	1	
None	CSC 407	Information Security	3	0	3	
None	CSC 220	Database Management Systems	3	0	3	
None	CSL 220	Database Management Systems Lab	0	1	1	
None	SEN 220	Software Engineering	3	0	3	
		University Elective - 2	-	-	3	

SEMESTER 5						
Pre-requisite	Course Code	Course Title	Theory	Lab	CR	CR/Sem
SEN 220	ITC 311	IT Project Management	3	0	3	16
CEN 222	ITC 312	System and Network Administration	3	0	3	
CEN 222	ITL 312	System and Network Administration Lab	0	1	1	
None	ITC 226	Web Systems & Technologies	2	0	2	
None	ITL 226	Web Systems & Technologies Lab	0	1	1	
SEN220	SEN458	Software Requirement Engineering	3	0	3	
		University Elective – 3	-	-	3	

SEMESTER 6						
Pre-requisite	Course Code	Course Title	Theory	Lab	CR	CR/Sem
CSC 220	ITC 321	Enterprise Systems	3	0	3	18
None	ITC 324	IT Infrastructure	3	0	3	
HSS 120	HSS 320	Technical Writing & Presentation Skills	3	0	3	
		University Elective - 4	-	-	3	
		IT Elective 1				
		IT Elective 2				

SUMMER						
Pre-requisite	Course code	Course Title	Theory	Lab	CR	CR/Sem
		Internship	0	0	0	0

SEMESTER 7						
Pre-requisite	Course code	Course Title	Theory	Lab	CR	CR/Sem
CEN 222	ITC 411	Cyber Security	3	0	3	18
None	PAK 101	Pakistan Studies	2	0	2	
CSC 220	ITC 424	Database Administration and Management	3	0	3	
CSC 220	ITL 424	Database Administration and Management Lab	0	1	1	
None	ESC 498	Project – I	-	-	3	
		IT Elective 3	-	-	3	
		IT Elective 4	-	-	3	
SEMESTER 8						
Pre-requisite	Course code	Course Title	Theory	Lab	CR	CR/Sem
None	ESC 499	Project – II	0	-	3	15
CSC 320	ITC 422	Virtual Systems and Services	3	0	3	
CSC 320	ITL 422	Virtual Systems and Services Lab	0	1	1	
None	ISL 101	Islamic Studies	2	0	2	
		IT Elective 5	-	-	3	
		IT Elective 6	-	-	3	
Total Credit Hours:						133

COMPUTER PROGRAMMING

Course Code:	CSC113
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The main course objectives are:

- To familiarize students with basic structured programming concepts.
- To emphasize upon problem analysis, logic building and program development skills.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of the basic concepts of programming	2	C2
2. **Exhibit** logic building ability using basic programming concepts	3	C2
3. **Apply** programming concepts to model requirements and solve simple computing problems using a high-level programming language	4	C3

Course Contents

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Diane Zak, An Introduction to Programming with C++, Eighth Edition, Course Technology
2. Paul. Deitel and Harvey. Deitel. , C++ How To Program, Eight Edition, Pearson, International Edition,
3. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Que Publishing,
4. Behrouz A. Forouzan, Richard F. Gilberg, Computer Science – A Structured Approach using C++, Second Edition, Cengage Learning,
5. C. M. Aslam, T. A. Qureshi, Programming with C++ Object-Oriented Programming, First Edition, Polymer Books

COMPUTER PROGRAMMING LAB

Course Code:	CSL113
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The main course objectives are:

- To practice basic structured programming concepts.
- To develop problem analysis, logic building, program design and debugging skills.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Demonstrate the understanding of programing language syntax and its usage	2	P2
2. Apply basic programming structures for logic construction	3	P3
3. Translate the devised solutions into computer programs and test the implementation	5	P3

Course Contents

Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison and logical operators, conditional statements and execution flow for conditional statements, repetitive statements and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			✓
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Diane Zak, An Introduction to Programming with C++, Eighth Edition, Course Technology
2. Paul. Deitel and Harvey. Deitel. , C++ How To Program, Eight Edition, Pearson, International Edition,
3. Robert Lafore, Object-Oriented Programming in C++, Fourth Edition, Que Publishing,
4. Behrouz A. Forouzan, Richard F. Gilberg, Computer Science – A Structured Approach using C++, Second Edition, Cengage Learning,
5. C. M. Aslam, T. A. Qureshi, Programming with C++ Object-Oriented Programming, First Edition, Polymer Books

INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGY	
Course Code:	CSC 114
Credit Hours:	2
Pre-requisite:	None

Course Objectives

The objectives of this course include making the students learn the fundamental concepts of computing technologies and enable them to apply the concepts of number systems, programming, and databases. Furthermore, understanding networking and internet technologies also makes part of this course.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Describe the components of a computer system	1	C1
2. Understand the fundamentals of operating systems, databases, and number systems	2	C2
3. Explain Networking and Internet Technologies	2	C2

Course Contents

Basic Definitions and Concepts, Hardware: Computer Systems and Components. Storage Devices, Number Systems. Software: Operating Systems, Programming and Application Software, Introduction to Programming, Databases and Information Systems, Networks, Data Communication, The Internet, Browsers and Search Engines, The Internet: Email, Collaborative Computing and Social Networking, The Internet: E-Commerce, IT Security, and other issues: Ad hoc networks, Introduction to cloud computing and virtualization.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✔		
PLO2 (Knowledge for Solving Computing Problems)		✔	✔
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Livesley, Robert Kenneth (2017) An introduction to automatic digital computers. Cambridge University Press.
2. June P & Dan O (2015), New Perspective on Computer, 16/e, Cengage Learning.
3. Charles S. Parker, (2014) Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
4. Deborah (2013), Understanding Computers, 14/e, Cengage Learning.
5. Gary B (2012), Discovering Computers, 1/e, South Western.
6. Peter Norton (2011), Introduction to Computers, 7/e, McGraw-Hill

INTRODUCTION TO INFORMATION AND COMMUNICATION TECHNOLOGY LAB	
Course Code:	CSL114
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The objectives of this course include making the students familiar with computer hardware and software and introduce them to common computer applications. Students will learn basic skills of different computer applications, apply concept of designing simple web pages and databases and implement the basic networks using different network topologies.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Observe the operations of various components of computing system	1	P1
2. Practice the basic computer application software like MS Word, MS Excel, MS Power Point, MS Access etc.	5	P3
3. Demonstrate the use of communication and networking	6	P4

Course Contents

The basics of Computer Science will be covered in the ICT lab. This lab is designed to teach the skills needed to become proficient with the basic primary Microsoft applications: Excel, PowerPoint, Access and Word, basics of Web Programing: Basic HTML and how to create basic networks using different network topologies

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✔		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)		✔	
PLO6 (Individual and Teamwork)			✔
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Livesley, Robert Kenneth (2017) An introduction to automatic digital computers. Cambridge University Press.
2. June P & Dan O (2015), New Perspective on Computer, 16/e, Cengage Learning.
3. Charles S. Parker, (2014) Understanding Computers: Today and Tomorrow, Course Technology, 25 Thomson Place, Boston, Massachusetts 02210, USA
4. Deborah (2013), Understanding Computers, 14/e, Cengage Learning.
5. Gary B (2012), Discovering Computers, 1/e, South Western.
6. Peter Norton (2011), Introduction to Computers, 7/e, McGraw-Hill

FUNCTIONAL ENGLISH

Course Code:	ENG105
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course incorporates four Basic English language skills – reading, writing, speaking and listening, with chief emphasis on class participation resulting in both written and verbal responses.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate English listening skills to function successfully in target language listening situation.	7	A1
2. Exhibit English reading skills to comprehend various aspects of the nature of the reading material.	7	A1
3. Practice English speaking skills to express effectively through speech.	7	A2
4. Demonstrate formal and informal English writing skills to express ideas and convey message to target readers.	7	C3

Course Contents

Basic English Composition, Introduction, Sentence and Structure, Components of a sentence, Types of Sentences, Subject verb agreement – Rules and common mistakes, The Reading Process, Skimming and scanning, reading for gist, Sample Reading Passages, How to look for contextual meanings, Types of readings, Looking for meaning, Writing a summary, Mechanics of writing, Brain storming and drafting, Writing a topic sentence and supporting details, Essays and types – basic, Basics of grammar in writing, Tenses, Reported speech, Verbs and types, The writing Process, Cohesion and coherence – introduction, Essays and types – basic, Story writing/ narrating an incident – structure and process, Common grammatical mistakes, Report Writing, Dialogue Writing, Oral Communication, Conversational Skills/Speaking, Presentation skills, Debate and speech, Agreements and disagreements, listening process, listening for specific information, Listening for gist, Basics of Grammar
– Grammar in Speech, Modifiers, Articles and determiners, Role Play, Phonetics and Phonology, Vowels and consonants, Stress and syllabification, Commonly mispronounced words, Sample audios and practice.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)	✓	✓	✓	✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342-1.
2. English Grammar in Use with Answers: A Self Study Reference and Practice Book by Raymond Murphy. Cambridge University Press, 2012.
3. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills.
   Third Impression 1992. ISBN 0 19 453402 2
4. Intermediate Listening Comprehension: Understanding and Recalling Spoken English by Patricial Dunkel and Phyllis L. Lim, Third Edition. ISBN 1 4130 1257 4.
5. College Writing Skills with Readings by John Langlan 9th Edition

APPLIED CALCULUS & ANALYTICAL GEOMETRY	
Course Code:	GSC110
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The main aim of this course is to introduce students with the fundamental concepts of calculus and analytical geometry. In addition to understanding of concepts, one of the key goals is to enable students to apply the learned concepts to solve various practical problems. The course will serve to help the Computer Science students to understand and solve the problems involving Mathematical and logical concepts in other courses and problem domains.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
Describe real value functions of one and more variables	1	C1
Apply the concepts of limits and continuity to solve problems in differential calculus	3	C3
Solve applied problems by applying concepts of Integration	3	C3

Course Contents

Limits and Continuity; Introduction to functions, Introduction to limits, Techniques of funding limits, Indeterminate forms of limits, Continuous and discontinuous functions and their applications, Differential calculus; Concept and idea of differentiation, Geometrical and Physical meaning of derivatives, Rules of differentiation, Techniques of differentiation, Rates of change, Tangents and Normal lines, Chain rule, implicit differentiation, linear approximation, Applications of differentiation; Extreme value functions, Mean value theorems, Maxima and Minima of a function for single-variable, Concavity, Integral calculus; Concept and idea of Integration, Indefinite Integrals, Techniques of integration, Riemann sums and Definite Integrals, Applications of definite integrals, Improper integral, Applications of Integration; Area under the curve, Analytical Geometry; Straight lines in R3, Equations for planes.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)		✓	✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Calculus and Analytic Geometry by Kenneth W. Thomas.
2. Calculus by Stewart, James.
3. Calculus by Earl William Swokowski; Michael Olinick; Dennis Pence; Jeffery A. Cole.

APPLIED PHYSICS

Course Code:	GSC114
Credit Hours:	2
Pre-requisite:	None

Course Objectives

Physics is the study of how the world works. This course introduces the physical world concepts that will be required in advance courses. This course will provide students with the knowledge of a wide variety of electric and magnetic phenomena. The course initiates with the basics of electricity at the atomic level and takes it to the circuit level for electric circuit analysis and design. Majority of the course is dedicated for electric and magnetic fields, forces, elements and their applications. Additionally, it also aims to provide introductory knowledge of wave theory and thermodynamic theory and optics in conjunction with their applications.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Comprehend** the working knowledge of fundamental laws of physics.	1	C2
2. **Apply** the knowledge of fundamental laws to solve various real-world problems	1	C3
3. **Analyze** different physical problems using the knowledge gained from different areas like electromagnetism, optics etc.	3	C4

Course Contents

Electric force and its applications and related problems, conservation of charge, charge quantization, Electric fields due to point charge and lines of force. Ring of charge, Disk of charge, A point charge in an electric field, Dipole in a n electric field, The flux of vector field, The flux of electric field, Gauss' Law, Application of Gauss' Law, Spherically symmetric charge distribution, A charge isolated conductor, Electric potential energy, Electric potentials, Calculating the potential from the field and related problem Potential due to point and continuous charge distribution, Potential due to dipole, equipotential surfaces, Calculating the field from the potential , Electric current, Current density, Resistance, Resistivity and conductivity, Ohm's law and its applications, The Hall effect, The magnetic force on a current, The Biot- Savart law, Line of B, Two parallel conductors, Amperes' s Law, Solenoid, Toroids, Faraday's experiments, Faraday's Law of Induction, Lenz's law, Motional emf, Induced electric field, Induced electric fields, The basic equation of electromagnetism, Induced Magnetic field, The displacement current, Reflection and Refraction of light waves, Total internal reflection, Two source interference, Double Slit interference, related problems, Interference from thin films, Diffraction and the wave theory, related problems, Single-Slit Diffraction, related problems, Polarization of electromagnetic waves, Polarizing sheets, related problems.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓	✓	
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Fundamentals of Physics (Extended), 10th edition, Resnick and Walker
2. Narciso Garcia, Arthur Damask, Steven Schwarz., “Physics for Computer Science Students”, Springer Verlag, 1998
3. David Halliday, Robert Resnick and Jearl Walker, Fundamentals of Physics, 10th Edition
4. Young and Freedman,” University Physics”, 13th Edition

APPLIED PHYSICS LAB

Course Code:	GSL114
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The key objectives of this course include:

1. To gain practical knowledge by applying the experimental methods and correlate the findings with the theoretical concepts in Physics.
2. To learn the usage of electrical and optical systems for various measurements.
3. To apply analytical techniques to data collected from experiments.
4. To discuss the basic principles of scientific concepts and apply these concepts while working in teams.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Develop the ability to record readings using different measurements tools.	5	P3
2. Demonstrate an understanding of basic laws of Physics through relevant experimentation.	6	P4
3. Show knowledge of constructing an electronic circuit for a given set of constraints.	3	P5

Course Contents

- Introduction to Measuring equipment (i.e., Vernier Caliper and Screw Gauge)
- Introduction to recently used electronic components.
- Finding resistance using color coding techniques & connecting them in series and parallel.
- Familiarization with analog and digital multi meter Vernier Caliper and Screw Gauge
- Verification of Ohm’s Law.
- Voltage divider and current divider.
- Kirchhoff’s voltage law & Kirchhoff’s current law.
- Magnetic lines of force.
- Familiarization with function generator and oscilloscope.
- Familiarization with light dependent resistor (LDR).
- Generating waveforms of different frequencies on oscilloscope.
- Familiarization with Semiconductor Diode biasing Characteristics.
- Familiarization with capacitor coding
- Charging and discharging of a capacitor.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)	✓		
PLO6 (Individual and Teamwork)		✓	
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Fundamentals of Physics (Extended) by Resnick and Walker, Publisher: Wiley, 10th edition (2015).
2. Narciso Garcia, Arthur Damask, Steven Schwarz. “Physics for Computer Science Students”, Springer Verlag (1998).
3. Essential Calculus-based Physics Study Guide Workbook: The Laws of Motion by Chris McMullen, Publisher: Zishka Publishing (2016)

OBJECT ORIENTED PROGRAMMING

Course Code:	CSC210
Credit Hours:	3
Pre-requisite:	Computer Programming

Course Objectives

The key objectives of this course include:

1. To understand the differences between traditional procedural design and object-oriented design
2. To provide a clear understanding of object-oriented concepts and their implementation
3. To analyse a problem from the perspective of the object oriented paradigm
4. To design and implement object oriented solutions to given problems

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Develop an understanding** of the underlying concepts of object-oriented paradigm	1	C2
2. **Apply** object-oriented concepts in solving computing problems	2	C3
3. **Design and implement** object-oriented solutions for small real-world problems	4	C4

Course Contents

Program design technique, Procedural vs. Object oriented Programming, Principles of Object-oriented Programming, Data Abstraction, Encapsulation, Classes and Objects, Function and Operator Overloading, Single and Multiple Inheritance, Polymorphism and Abstract Classess, Exception Handling, Stream I/O and File Processing, Class Templates.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. C++ How to Program, by Deitel & Deitel, 10th Edition, 2017, Pearson.
2. Matt Weisfeld (2018), The Object-Oriented Thought Process, 4th Edition, Wiley.
3. Joyce Farrell (2019), An Object-Oriented Approach to Programming Logic and Design, 5th Edition Hall, Course Technology.

OBJECT ORIENTED PROGRAMMING LAB	
Course Code:	CSL210
Credit Hours:	1
Pre-requisite:	Computer Programming

Course Objectives

The key objectives of this course include:

1. To provide basic understanding of the tool used for the implementation of object-oriented concepts
2. To practice the implementation of object-oriented concepts using a programming language
3. To design and implement object-oriented programs for computational problems.
4. To test and debug object-oriented programs.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Demonstrate an understanding of object-oriented design concepts and their mapping to object-oriented programming	4	P3
2. Implement and debug object-oriented solutions for problems involving multiple classes	5	P4
3. Demonstrate effective communication and teamwork	6	A2

Course Contents

Program design technique, Procedural vs. Object oriented Programming, Basic Principles of Object- oriented Programming, Data Abstraction, Encapsulation, Classes and Objects, Function and Operator Overloading, Single and Multiple Inheritance, Polymorphism and Abstract Classes, Exception Handling, Stream I/O and File Processing, Class Templates.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)	✓		
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. C++ How to Program, by Deitel & Deitel, 10th Edition, 2017, Pearson.
2. Matt Weisfeld (2018), The Object-Oriented Thought Process, 4th Edition, Wiley.
3. Joyce Farrell (2019), An Object-Oriented Approach to Programming Logic and Design, 5th Edition Hall, Course Technology.)

COMMUNICATION SKILLS

Course Code:	HSS120
Credit Hours:	3
Pre-requisite:	Functional English

Course Objectives

The general focus of the course is on clarifying and broadening the students' understanding of verbal and written English by comparing what they already know. The aim is to provide the students with a course that focuses on their needs as learners of English in the present day. Accordingly, the emphasis will be on the communicative use of contemporary English for practical purposes. The course will, therefore, provide material not only to extend the students' general language proficiency, but also to systematically develop their abilities to use English as a tool for study and to prepare them for their future careers.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Participate actively in group discussions by exercising attentive listening and constructive debate.	6	A2
2. Initiate a conversation and communicate effectively by employing intermediate-to advanced level English vocabulary.	7	A3
3. Express or present ideas independently in front of an audience and effectively respond to queries.	7	A3
4. Write formal business letters by applying technical writing skills.	7	C3

Course Contents

Business Writing: Seven Cs of Communication, Business Writing Styles, Business Memos, Business Emails, Tenders and Quotations, Billing and Invoicing, Common Writing Errors, Useful Vocabulary and Phrases, Personal Documents, Oral Communication: Verbal and non-verbal communication, Conducting meetings, Small group communication, Taking minutes, Presentation Skills: Presentation Strategies, Defining the Objective, scope and audience of the presentation, Material gathering and material organization strategies, Time management, Opening and concluding, Use of Visual audio- visual aids, Delivery and presentation, Activities Involved: Interactive session of students for communication skills followed by assessment with defined rubrics.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)	✓			
PLO7 (Communication)		✓	✓	✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Anchor in English-II (Lessons 1-5), A SPELT Publication
2. Christopher Fry, “Summary Writing (Book-I)”, Oxford University Press
3. College Essays by John Langlan
4. Barron’s TOFFLiBT Edition
5. Communication Skills for Engineers by Sunita Marshal and C.Muralikrishna
6. Practical English Grammar by A. J. Thomson and A. V. Martinet. Fourth edition. Oxford University Press. ISBN 978-0-19-431342
7. Practical English Grammar Exercises 1 by A. J. Thomson and A. V. Martinet. Third edition. Oxford University Press. ISBN 978-0-19-431349-0.
8. A Practical Guide to Business Writing: Writing in English for Non-Native Speakers by Khaled Mohamed Al Maskari. Wiley. ISBN 978 1 118 41079 0

DIGITAL DESIGN

Course Code:	CEN122
Credit Hours:	3
Pre-requisite:	Applied Physics

Course Objectives

1. To understand fundamentals of Digital Logic Design, binary systems and digital systems
2. To understand the implementation of Boolean algebra and K-maps for simplification of digital logic circuits.
3. To understand combinational logic i.e., coders, decoders, multiplexers, de-multiplexers, adders etc.,
4. To get familiarization with different types of designs in sequential logic circuits i.e. FFs, Shift registers counters through state machines etc.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understanding** of the Boolean Algebra, Boolean Functions, Combinational and Sequential Logic and PLDs	1	C2
2. **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques	2	C3
3. **Understand** the relationship between abstract logic characterizations and practical electrical implementations.	3	C2

Course Contents

Number Systems, Logic Gates, Boolean Algebra, Combination logic circuits and designs, Simplification Methods (K-Map, Quinn Mc-Cluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Binary Arithmetic and Arithmetic Circuits, Memory Elements, State Machines.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Digital Logic Design by Morris Mano, Michale D. Ciletti 5rd edition Publisher Pearson Copy Right 2015.
2. Digital Fundamentals by Thomas L. Floyd, 10th edition, Publisher: Pearson 2015
3. Digital Electronics : An Introduction To Theory And Practice by William Gothmann H, 2011
4. Digital Electronics by John Morris, 2012

DIGITAL DESIGN LAB

Course Code:	CEL122
Credit Hours:	1
Pre-requisite:	Applied Physics

Course Objectives

1. To Identify and work with number systems and codes.
2. To Understand logic gates, combinational circuits, Boolean Algebra, and simplification by using Karnaugh maps.
3. To Design and understand the working of simple logic circuits like comparator, adders, encoder, decoders, multiplexers and de-multiplexers.
4. To Understand the working of latches, flip flops, synchronous and asynchronous counters, clocks, shift registers.
5. To Understand memory structure and basic operations.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the tools and techniques for the design of digital electronic circuits	1	C2
2. **Demonstrate** the skills to design and analyze both combinational and sequential circuits using a variety of techniques	2	P3
3. **Apply** the acquired knowledge to simulate and implement small-scale digital circuits	3	P4

Course Contents

Implementation of: AND, OR, NAND, NOR and NOT gates, simple circuits from given expression, gates using universal gates, parity generator with checker, half adder and full adder, multiplexer using gates , decoder using basic gates ,adder and subtractor using Integrated circuits.SR latches & SR latches with control bit, D Latch & D Flip Flops, SR Flip Flop, JK Flip Flop, Toggle Flip Flop.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Digital Logic Design by Morris Mano, 5th Edition, Publisher: Pearson, 2013
2. Digital Fundamentals by Thomas L. Floyd, 10th edition, Publisher: Pearson 2011
3. Digital Electronics : An Introduction To Theory And Practice by William Gothmann H, 2011
4. Digital Electronics by John Morris, 2012

DISCETE MATHEMATICS

Course Code:	GSC221
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To provide students with a solid understanding of Discrete Mathematics.
2. To introduce students to the fundamental as well as advanced concepts of Set theory, Algorithms, Functions, Mathematical reasoning, Graph Theory, and Trees.
3. To enable students improve problem-solving skills of enumerating objects using combinatorial analysis.
4. To enable students learn about the abstract Mathematical structures used to represent discrete objects and relationships between these objects.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of the key concepts of Discrete Structures.	1	C2
2. **Relate** various discrete structures with different areas of Computer Science.	2	C2
3. **Apply** formal logic proofs and/or informal, but rigorous, logical reasoning to real world problems.	3	C3
4. **Develop** pseudocodes of algorithms for standard computing problems.	4	C3

Course Contents

Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory, relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, euler graph, Hamiltonian path, rooted trees, traversals.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Discrete Mathematics and Its Applications by Kenneth H. Rosen
2. Discrete Mathematics with Applications by Susanna S. Epp
3. Discrete Mathematics by Richard Johnson Baugh
4. Discrete Mathematical Structures by Kolman, Busby & Ross
5. Discrete and Combinatorial Mathematics: An Applied Introduction by Ralph P. Grimaldi
6. Logic and Discrete Mathematics: A Computer Science Perspective by Winifred Grassman

DATA STRUCTURES AND ALGORITHMS	
Course Code:	CSC221
Credit Hours:	3
Pre-requisite:	Computer Programming

Course Objectives

The primary objective of the course is to help students understand the importance of data structures and well-designed algorithms for efficient management of computing resources while programming. Popularly employed linear and nonlinear data structures are described from the perspective of their specification, application, and implementation. Several sorting and searching techniques are also discussed to help students design efficient solutions for real life problems. Basic knowledge of algorithm's complexity analysis is also provided for identification of time costly processes**.**

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** and **compare** different data structures and their applications	1	C2
2. **Apply** appropriate data structures according to the given scenarios and application domain.	2	C3
3. **Analyze** time complexity of different algorithms	2	C4
4. **Design** efficient algorithm(s) to solve real-world problems	4	C6

Course Contents

Abstract Data Types (ADTs) , Linear data structures (Stacks, Queues, Linked list), Non-linear data structures (Trees, Graphs), Recursion and recursive algorithms, Sorting Algorithms (Bubble, Insertion, Selection, Quick, Merge, Shell, Heap), Searching (Linear, Binary, Depth First, Breadth First, Shortest Path, Minimum Spanning Trees), Hashing and Collision resolution techniques (Open Addressing, Separate Chaining, Double Hashing), Data Compression (Huffman's Code), Complexity Analysis of Algorithms (Big-O notation)

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓	✓	
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss, 7th Edition, Published by Addison-Wesley, 2019.
2. Data Structures and Algorithms in C++, by Drozdek Adam, 6th Edition, 2020
3. Data Structures and Algorithms using C & C++, Augenstein & Tenenbaum, 2019.
4. C++ Plus Data Structures, 7th Edition, Nell Dale, Jones and Bartlett Learning, 2020.
5. Data Structures using C++, Varsha H. Patil, 6th Edition, Oxford University Press, 2018.

DATA STRUCTURES & ALGORITHMS LAB	
Course Code:	CSL221
Credit Hours:	1
Pre-requisite:	Computer Programming

Course Objectives

This lab is aimed at implementing common linear and nonlinear data structures, sorting techniques, and hashing algorithms to solve various programming tasks with efficiency.

The primary objectives of the course include the following.

1. Implement efficient data structures for real world problem solving.
2. Design & implement various operations on commonly used linear/non-linear data structures.
3. To employ efficient techniques for searching and sorting data.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Implement different linear and non-linear data structures	3	P3
2. Construct programs for problems and application domain by using appropriate data structures.	4	P4
3. Demonstrate effective teamwork in solving problems	6	A2

Course Contents

The key concepts covered in the course include basics of data structures and abstract data types, algorithms, linear data structures: stacks, queues, linked lists and variants, non-linear data structures: trees, heaps and graphs, operations on data structures, sorting algorithms, hashing and complexity analysis of algorithms.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)	✓		
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Data Structures and Algorithm Analysis in C++, by Mark Allen Weiss, 7th Edition, Published by Addison-Wesley, 2019.
2. Data Structures and Algorithms in C++, by Drozdek Adam, 6th Edition, 2020
3. Data Structures and Algorithms using C & C++, Augenstein & Tenenbaum, 2019.
4. C++ Plus Data Structures, 7th Edition, Nell Dale, Jones and Bartlett Learning, 2020.
5. Data Structures using C++, Varsha H. Patil, 6th Edition, Oxford University Press, 2018

DATA COMMUNICATION & NETWORKING	
Course Code:	CEN222
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To develop understanding of the concepts related to Data Communication & Networks
2. To provide the detailed insight into the layered structure of OSI and TCP/IP Models.
3. To enable to apply knowledge of Data Communication & Networks and layered models in analysis, problem solving and developing small and medium scale networks**.**

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** basic principles and functionalities of Data Communication and Networks.	1	C2
2. **Explain** the services and functions provided by each layer in the Internet protocol stack.	2	C2
3. **Identify** various internetworking devices and protocols, and their functions in a network.	2	C3

Course Contents

Network Models: Communication Model, Layered Protocol Architecture, OSI Reference Model, TCP/IP Architecture. **Physical Layer and Media**: Data and Signals, Digital Transmission, Analog Transmission**,** Bandwidth Utilization: Multiplexing**,** Switching**, Data Link Layer:** Error Detection and Correction, Data Link Control, Multiple Access, Ethernet, LAN and VLAN. Network Layer: Logical Addressing, Internet Protocol, IP Packet (IPv4), IP Addressing and Routing: IP Classes and Subnetting, Address Resolution Protocol (ARP), Reverse Address Resolution Protocol (RARP), Internet Control Message Protocol (ICMP), Internet Group Management Protocol (IGMP). **Routing Algorithms:** Link State Routing, Distance Vector Routing, Address Mapping, Error Reporting and Multicasting, Delivery, forwarding and routing. **Transport Layer:** Process to Process Delivery: UDP, TCP and SCTP, Congestion Control. **Application Layer:** Domain Name System (DNS), Electronic Mail and File Transfer, WWW and HTTP.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	✓
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Behrouz A. Forouzan, “TCP/IP Protocol Suite”, McGraw-Hill. (Latest Edition)
2. A. Leon-Garcia, “Communication Networks”, McGraw-Hill. (Latest Edition)
3. William Stallings, “Data and Computer Communication”, Prentice Hall. (8th Edition)

DATA COMMUNICATION & NETWORKING LAB	
Course Code:	CEL222
Credit Hours:	1
Pre-requisite:	None

Course Objectives

This is a basic level lab course emphasizing on the network design and configuration of devices in a network. This lab familiarizes students with IP addressing, its classes and classless IP addressing technique, configurations of Switches and Routers and application of different switching and routing protocols. At the end of the course, students are expected to be able to design, analyze and simulate medium-sized networks.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Make** different cable types.	1	P2
2. **Apply** and simulate different routing protocols like RIP, OSPF, NAT and ACL.	5	P3
3. **Build** Computer Network (s) on various topologies.	6	P3

Course Contents

- Basic cable construction and testing (straight, cross-over)
- Introduction to Packet Tracer and building and testing a Peer-to-Peer network physically and on packet Tracer.
- Introduction to Switch and Router & their Command Line Interface (CLI) fundamentals.
- Establishing a console session with CISCO Router 3900 Series Using HyperTerminal, retrieving configurations from NVRAM and TFTP server and configuring DHCP.
- Building and testing a Router based network using Static Routing.
- Building and testing VLAN and Inter-VLAN in switch domain network.
- Configuring RIP between routers.
- Configuring Access Control Lists (ACLs) on a Router.
- Configuring OSPF and Mutli-area OSPF between routers.
- Configuring Network Address Translation (NAT) on a Router.
- Configuring Wired LANS and WLANs in Wireshark Packet Analyzer.
- Configuring IoTs in Packet Tracer
- Configuring DSL and VoIP in Packet Tracer.
- Open-Ended Lab

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			✓
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

Tools

- Packet Tracer 7.2
- Wireshark Network Analyzer 2.6.0
- Hyper Terminal
- Cisco Switch 2600 series
- Cisco Router 3900 series

PROFESSIONAL PRACTICES

Course Code:	CSC307
Credit Hours:	3
Pre-requisite:	None

Course Objectives

- To enhance key factors of interpersonal relations.
- To build social ethics.
- To know organizational behavior so that individual and team works can be done in a more professional way without compromising organization principles and without hurting others interests.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. Identify the content of religious, national, or international law dealing with professional ethics	8	A2
2. Apply the knowledge of ethics in their personal and professional life	9	A3
3. Gain the ability to enhance key factors of interpersonal relations, to follow and implement the acquired knowledge of ethical skills in given situations by controlling his/her temperament.	10	A4

Course Contents

Computing Profession, Computing Ethics, Philosophy of Ethics. The Structure of Organizations, Finance and Accounting, Anatomy of a Software House, Computer Contracts, Intellectual Property Rights, The Framework of Employee Relations Law and Changing Management Practices, Human Resource Management and IT, Health and Safety at Work, Software Liability, Liability and Practice, Computer Misuse and the Criminal Law, Regulation and Control of Personal Information. Overview of the British Computer Society Code of Conduct, IEEE Code of Ethics, ACM Code of Ethics and Professional Conduct, ACM/IEEE Software Engineering Code of Ethics and Professional Practice. Accountability and Auditing, Social Application of Ethics

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)	✓		
PLO9 (Ethics)		✓	
PLO10 (Life-long Learning)			✓

Resources

1. Professional Issues in Software Engineering by Frank Bott, Allison Coleman, Jack Eaton and Diane Rowland, CRC Press; 3rd Edition (2000). ISBN-10: 0748409513
2. Computer Ethics by Deborah G. Johnson, Pearson; 4th Edition (January 3, 2009). ISBN10: 0131112414
3. A Gift of Fire: Social, Legal, and Ethical Issues for Computing and the Internet (3rd Edition) by Sara Baase, Prentice Hall; 3rd Edition (2008). ISBN-10: 0136008488
4. Applied Professional Ethics by Gregory R. Beabout, University Press of America (1993). ISBN- 10: 0819193747

LINEAR ALGEBRA

Course Code:	GSC121
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course aims to familiarize the students with the basic concepts of linear algebra, thorough understanding of matrix operations, vector spaces, linear transformations eigen values and eigen vectors and diagonalizations. Furthermore, the course also aims at enhancing students' ability to reason Mathematically and enable them to apply this knowledge to other fields in of Computer Science.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Interpret** the fundamental concepts of linear algebra, vector equations and linear transformations.	1	C2
2. **Apply** the basic knowledge of vector spaces, eigen value and eigen vectors to solve the critical problems of Linear Algebra.	2	C3
3. **Solve** systems of linear equations appearing in different engineering applications.	3	C3

Course Contents

Algebra of linear transformations and matrices. determinants, rank, systems of equations, vector spaces, orthogonal transformations, linear dependence, linear Independence and bases, eigenvalues and eigenvectors, characteristic equations, Inner product space and quadratic forms, Applications of linear systems.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Elementary Linear Algebra by Howard Anton
2. Linear Algebra and its Applications by Gibert Strang

PROBABILITY & STATISTICS	
Course Code:	GSC122
Credit Hours:	3
Pre-requisite:	None

Course Objectives

1. To familiarize students with various statistical concepts and methods and enable them to develop statistical reasoning.
2. To understand and apply the concepts of Probability theory.
3. To provide students, the knowledge of different Probability distributions and their applications in Computer Science.
4. To enable the students to learn and apply the tools for curve fitting via Linear Regression and Correlation.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** and **express** the basic understanding of probability and statistics.	1	C2
2. **Demonstrate** an ability to use descriptive techniques to describe the statistical data.	2	C2
3. **Apply** inferential statistical methods to solve problems.	3	C3
4. **Analyze** and investigate any given data distribution.	3	C4

Course Contents

Introduction to Statistics and Data Analysis, Statistical Inference, Samples, Populations, and the Role of Probability. Sampling Procedures. Discrete and Continuous Data. Statistical Modeling. Types of Statistical Studies. Probability: Sample Space, Events, Counting Sample Points, Probability of an Event, Additive Rules, Conditional Probability, Independence, and the Product Rule, Bayes' Rule. Random Variables and Probability Distributions. Mathematical Expectation: Mean of a Random Variable, Variance and Covariance of Random Variables, Means and Variances of Linear Combinations of Random Variables, Chebyshev's Theorem. Discrete Probability Distributions. Continuous Probability Distributions. Fundamental Sampling Distributions and Data Descriptions: Random Sampling, Sampling Distributions, Sampling Distribution of Means and the Central Limit Theorem. Sampling Distribution of S2, t-Distribution, F-Quantile and Probability Plots. Single Sample & One- and Two- Sample Estimation Problems. Single Sample & One- and Two-Sample Tests of Hypotheses. The Use of P-Values for Decision Making in Testing Hypotheses (Single Sample & One- and Two-Sample Tests), Linear Regression and Correlation. Least Squares and the Fitted Model, Multiple Linear Regression and Certain, Nonlinear Regression Models, Linear Regression Model Using Matrices, Properties of the Least Squares Estimators.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	✓
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Probability and Statistics for Engineers and Scientists by Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers and Keying E. Ye, Pearson.
2. Probability and Statistics for Engineers and Scientists by Anthony J. Hayter, Duxbury Press; 4^{TH} edition.
3. Schaum's Outline of Probability and Statistics, by John Schiller, R. Alu Srinivasan and Murray Spiegel, McGraw-Hill.

OPERATING SYSTEMS

Course Code:	CSC320
Credit Hours:	3
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The key objectives of this course include enabling the students to understand the basic components of a computer operating system, and the interactions among the various components. The course will also cover the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	1	C2
2. **Apply** the concepts of memory management, I/O management CPU management and processor management etc.	2	C3
3. **Analyze** the algorithms of the core functions of Operating Systems and explain the major performance issues with respect to the core functions.	3	C4

Course Contents

Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

OPERATING SYSTEMS LAB

Course Code:	CSL320
Credit Hours:	1
Pre-requisite:	Data Structures and Algorithms

Course Objectives

The Operating Systems lab aims to enable students different key concepts of Operating Systems. Students will apply system software and tools available in modern operating systems to develop a deeper understanding of the underlying concepts. The labs will also cover the policies for scheduling, deadlocks, memory management, synchronization, system calls, and file systems.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. Implement OS concepts like those of shell scripting, processes, file manipulation and inter-processes communication.	3	P2
2. Demonstrate the knowledge in applying system software and tools available in modern operating systems.	5	P4

Course Contents

Introduction to Operating Systems, Linux Operating System, Introduction and configuration of the Virtual Machine, VMware tools Installation, Ubuntu Installation, Understanding utility Linux Commands, File Commands, Filter and pipes, Introduction to Shell programming, Common Shells, keywords, Shell variables and their types, Metacharacters, Arithmetic operators and expressions, single and multiple user inputs, Positional Parameters in Shell programming, Different types of operators and expressions, Conditional statements, Nested Conditional statements (if-else, switch case), file testing, execution of shell script, Scripts for automation a process e.g. copying contents of one file to another. Command substitution in scripts, Process Creation through fork system call, Sleep Command, Inter-processes Communication, System calls, Implementation of Filing through System calls, CPU scheduling, Multi-Threading, sharing of variables between two or more threads, Synchronization to avoid deadlock, Using Semaphore, Implementation of Synchronization between multiple threads, Signal handling.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**
PLO1 (Academic Education)		
PLO2 (Knowledge for Solving Computing Problems)		
PLO3 (Problem Analysis)	✓	
PLO4 (Design/Development of Solutions)		
PLO5 (Modern Tool Usage)		✓
PLO6 (Individual and Teamwork)		
PLO7 (Communication)		
PLO8 (Computing Professionalism and Society)		
PLO9 (Ethics)		
PLO10 (Life-long Learning)		

Resources

1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

INFORMATION SECURITY

Course Code:	CSC407
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The objective of this course is to equip the students with the basic yet essential knowledge of the concepts of information security, confidently, integrity and availability, authentication models, IDS systems and cryptography techniques. By the end of this course, the students will be able to apply their knowledge of information security policy formation and enforcement in communication networks.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** key concepts of information security such as design principles, cryptography, risk management, and ethics.	2	C2
2. **Apply** various security and risk management tools for achieving information security and privacy.	5	C3
3. **Identify** appropriate techniques to tackle and solve problems in the discipline of information security.	3	C4
4. **Create** solutions to real life scenarios using different security related tools.	4	C6

Course Contents

Information security foundations, security design principles; security mechanisms, symmetric and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓			
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)		✓		
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Cryptography and Network Security by William Stallings. Publisher: Pearson ,6th Edition (2012).
2. Computer Security Art and Science by Matt Bishop, Publisher: Addison-Wesley Professional; 2nd edition (2018).
3. Computer Security: Principles and Practice, 3rd edition by William Stallings
4. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
5. Computer Security, 3rd edition by Dieter Gollmann
6. Computer Security Fundamentals, 3rd edition by William Easttom

DATABASE MANAGEMENT SYSTEMS

Course Code:	CSC220
Credit Hours:	3
Pre-requisite:	None

Course Objectives

They key objectives of this course include:

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
- To understand and use data manipulation language to query, update, and manage a database.
- To develop an understanding of essential DBMS concepts such as: database security, integrity, and concurrency.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** the fundamental concepts of databases	2	C2
2. **Apply** different database models to design conceptual, logical, and physical databases	4	C3
3. **Apply** queries to extract information from databases	5	C3
4. **Analyze** user requirements to design a database for the given scenarios	4	C4

Course Contents

Basic database concepts, Database approach vs. file-based system, Database architecture, Three level schema architecture, Data independence, Relational data model, Attributes, schemas, tuples, domains, relation instances, keys of relations, Integrity constraints, Relational algebra, selection, projection, Cartesian product, Types of joins, Normalization, functional dependencies, normal forms , Entity relationship model, entity sets, attributes , Relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and sub-queries in SQL, Grouping and aggregation in SQL , Concurrency control, Database backup and recovery, Indexes, NoSQL systems.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓			
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)		✓		✓
PLO5 (Modern Tool Usage)			✓	
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom
3. Database System Concepts, 7th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke

DATABASE MANAGEMENT SYSTEMS LAB	
Course Code:	CSL220
Credit Hours:	1
Pre-requisite:	None

Course Objectives

Students successfully completing this course should be able:

- To understand the different issues involved in the design and implementation of a database system.
- To study the physical and logical database designs, database modeling, relational, hierarchical, and network models.
- To understand and use data manipulation language to query, update, and manage a database.
- To develop an understanding of essential DBMS concepts such as: database security, integrity, and concurrency.
- To familiarize with the concepts of distributed database, and intelligent database, Client/Server (Database Server), data warehousing and data mining.
- To design and build a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Practice** writing SQL commands to perform different tasks	4	P3
2. **Make** ER diagrams as to analyze and interpret data design of database	3	P4
3. **Make** a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS	5	P4

Course Contents

- Introduction to DBMS, SQL, Installation of tool, and interaction with tool.
- Overview of The SQL Query Language, Database Design, Data retrieval Language, Query Processing.
- Basic Query Structure, Conditional Queries Additional Basic Operations
- Data Definition Language
- Data Manipulation Language
- Set operations and Aggregate functions.
- SQL Case Study
- Entity Relationship Diagram and Relational Database Design, Entity Relationship Model
- Design Process, Modeling Constraints, E-R Diagram

- Group By, Having, Order By
- Views
- Sub-queries
- JOINS, Self-Join, Left Outer Join, Inner Join, Full Outer Join
- Application Design and Development Using .Net framework, Microsoft Visual Studio
- Transactions and Concurrency, Backup and Recovery

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)		✓	
PLO4 (Design/Development of Solutions)	✓		
PLO5 (Modern Tool Usage)			✓
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Database System Concepts, Sixth Edition. Avi Silberschatz, Henry F. Korth, S. Sudarshan.
   McGraw-Hill, 2010. ISBN 0-07-352332-1
2. Modern Database Management by Fred McFadden, Jeffrey Hoofer, Mary Prescott, Prentice Hall; 11th Edition (July 26, 2012). ISBN-10: 0132662256
3. Fundamentals of Database Systems by R. Elmasri and S. Navathe. 6th Edition, Addison-Wesley (2010). ISBN-10: 0136086209.

SOFTWARE ENGINEERING

Course Code:	SEN220
Credit Hours:	3
Pre-requisite:	None

Course Objectives

The objectives of this course include developing an understanding of Software Engineering and different software development paradigms. Comprehension of the importance of requirements and classifying the requirements and usage of UML in designing a Software also make part of the key objectives. The course also aims to equip the students with the skills required to construct quality software, which is reliable, reasonably easy to understand, modify and maintain.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Describe** various software engineering processes and activities	1	C1
2. **Apply** knowledge of software engineering appropriate to the discipline, particularly in the modeling, design, testing and deployment of software systems.	4	C3
3. **Analyze** and solve small-scale Software Engineering problems	3	C4

Course Contents

Introduction to Software & Software Engineering, Socio-Technical Systems, Emergent System Properties Legacy Systems, and Critical Systems, FAQs about Software Engineering, Professional and Ethical Responsibility, Key challenges in software engineering, Attributes of a quality software, Software Process Models: Process Activities, Plan Driven Models Coping with Change, Plan Driven Models (continued), Incremental Development Processes Spiral Model, Agile Software Development, Agile Processes Plan Driven and Agile development, Requirements Engineering: Functional & non -functional requirements, Requirements Specification Elicitation and Analysis, Requirements Validation, Requirements Engineering Process, System Modeling: Context Model, Interaction Model, Structural Model, Behavioral Model, Design and Implementation: OO, UML Introduction, UML Design Patterns, UML Design Patterns, Use case Introduction, Use case Diagrams, Activity Diagrams, Sequence Diagrams, Package Diagrams, Architectural Design Introduction, Architectural Design Decisions, Architectural Views and Patterns, Software Testing, Development Testing, Release Testing User Testing, Software Evolution

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Software Engineering, 9th Edition, Ian Somerville, Addison-Wesley, 2011
2. Software Engineering Modern Approaches, 2nd Edition, Eric J. Braude, Michel E. Bernstein, Wiley & Sons, INC, 2011
3. UML Distilled A Brief Guide to The Standard Object Modeling Language, by Martin Fowler
4. Object-Oriented Modeling and Design with UML by Michael R Blaha, James R Rumbaugh
5. Designing Flexible Object-Oriented Systems with UML by Charles Richter, Techmedia

IT PROJECT MANAGEMENT

Course Code:	ITC311
Credit Hours:	3
Pre-requisite:	Software Engineering

Course Objectives

This course will enable students to identify the characteristics of IT project management and the roles involved in designing, developing, and delivering IT projects; describe the necessary management and control of complexity that is a part of IT projects and understand how to align the needs of an organization's business, and the usefulness of IT technology, tools, and applications.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the key elements of the IT project management framework and explain the principles of project life cycle.	1	2
2. Work in teams to **plan** various project activities in a scientific way to monitor performance.	6	3
3. **Implement** and manage project schedule using appropriate project management tools.	5	3
4. **Choose** appropriate project management techniques for IT projects.	2	5

Course Contents

IT Project Management fundamentals and concepts, the sequential steps of IT Project Management, Software Development vs. IT Project Management, Functions of Project Management and Leadership, Project processes of initiating, planning, executing, controlling and closing the project, Roles of the Project Manager and the team members, Communicate with the project team, clients and customer (sponsor), Management of the project scope, project time and work flow, project cost, project budgets, project resources, project quality, project human resource requirements, project communication (reports, meetings, correspondence, etc.) project changes and project risk management, IT project management principles in real life scenarios.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)				✓
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)			✓	
PLO6 (Individual and Teamwork)		✓		
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Information Technology Project Management by Kathy Schwalbe, Course Technology; 8th Edition. ISBN-10: 1285452348
2. Software Project Management (5th ed.), by Bob Hughes and Mike Cotterell, McGraw-Hill, (2009). ISBN-13: 978-1118911013, ISBN-10: 1118911016
3. Guide to the Project Management Body of Knowledge (PMBOK) 5th Edition, 2013, PMI, Advanced, ISBN-13: 9781935589679, ISBN-10: 1935589679
4. IT Project Management: On Track from Start to Finish by Joseph Phillips, McGrawHill Osborne Media; 3rd Edition ISBN-10: 0071700439 4.
5. Information Technology Project Management by Jack T. Marche, Wiley; 3rd Edition (January 6, 2009). ISBN-10: 0470371935

SYSTEM AND NETWORK ADMINISTRATION

Course Code:	ITC312
Credit Hours:	3
Pre-requisite:	Data Communication and Networking

Course Objectives

The objective of this course is to introduce students to the key concepts in system and network administration. The course provides the basic theory, concepts and practical experience in the design, installation and configuration of personal computers, peer-to-peer networks and client-server networks meeting user requirements. By the end of this course, students should be able to apply their knowledge of system and network administration and install and configure a client-server based network.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of the basic principles and functionalities of system and network administration.	2	C2
2. **Design** the network architecture for a given scenario.	4	C3
3. **Analyze** the requirements and design and configure a client-server network and the network services for a given scenario.	3	C4

Course Contents

Introduction to System Administration, SA Components, Server Environment (Microsoft and Linux), Reliable Products, Server Hardware Costing, Maintenance Contracts and Spare Parts, Maintaining Data Integrity, Client Server OS Configuration, Providing Remote Console Access, Comparative Analysis of OS: Important Attributes, Key Features, Pros and Cons, Linux Installation and Verification, Configuring Local Services and Managing Basic System Issues, Administer Users and Groups, Software Management, Managing Network Services and Network Monitoring Tools, Boot Management and Process Management, IP Tables and Filtering, Securing Network Traffic, Advanced File Systems and Logs. Bash Shell Scripting. Configuring Servers (FTP, NFS, Samba, DHCP, DNS and Apache).

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)	✓		
PLO3 (Problem Analysis)			✓
PLO4 (Design/Development of Solutions)		✓	
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. The Practice of System and Network Administration, Second Edition by Thomas Limoncelli, Christina Hogan and Strata Chalup, Addison-Wesley Professional; 2nd Edition (2007). ISBN-10: 0321492668
2. Red Hat Enterprise Linux 6 Bible: Administering Enterprise Linux Systems by William vonHagen, 2011
3. Studyguide for Practice of System and Network Administration by Thomas A. Limoncelli, Cram101; 2nd Edition (2011). ISBN-10: 1428851755 4. Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009).

SYSTEM AND NETWORK ADMINISTRATION LAB

Course Code:	ITL312
Credit Hours:	1
Pre-requisite:	Data Communication and Networking

Course Objectives

This lab course emphasizes on concepts of system and network administration and its practical aspects. After successfully completing the lab sessions, the students are expected to understand and be able to design and implement peer-to-peer as well as client-server networks along with the associated services.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Design** and configure peer-to-peer and client-server networks.	6	P4
2. **Configure** IP Addressing schemes, DNS, DHCP and FTP etc.	5	P4
3. **Manage** network services and network monitoring tools.	5	P4

Course Contents

Windows Server installation and administration, Adding Roles and Features, Domain Name System (DNS), Active Directory and Active Directory Domain Name Service, Fine-Grained password policies in Active Directory Domain Name Service, Shared folder setup, File server and Disk quota management, Group Policy Management, Audit policy, Dynamic Host Configuration Protocol (DHCP), Configuration of File transfer protocol (FTP), Install and configure a print server, Backup and Restore, Removing roles and features from server, Design and configure peer-to-peer networks to share resources, Designing network architecture, configuring IP addressing schemes, Configuration of a client-server network and services.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)		✓	✓
PLO6 (Individual and Teamwork)	✓		
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. The Practice of System and Network Administration, Second Edition by Thomas Limoncelli, Christina Hogan and Strata Chalup, Addison-Wesley Professional; 2nd Edition (2007). ISBN-10: 0321492668.
2. Red Hat Enterprise Linux 6 Bible: Administering Enterprise Linux Systems by William vonHagen, 2011.
3. Studyguide for Practice of System and Network Administration by Thomas A. Limoncelli, Cram101; 2nd Edition (2011). ISBN-10: 1428851755 4. Networking Systems Design and Development by Lee Chao, CRC Press; 1st Edition (December 21, 2009).

WEB SYSTEMS AND TECHNOLOGIES

Course Code:	ITC226
Credit Hours:	2
Pre-requisite:	None

Course Objectives

The key objectives of this course include:

- To understand the basic structure of Web engineering.
- To learn the use of Web tools and develop a simple Web Application.
- To design and synthesize new techniques of Web modeling.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Discuss** how web standards impact software development.	2	2
2. **Describe** the constraints that the web puts on developers.	2	2
3. **Design** and **Implement** a simple web application.	4	4
4. **Review** an existing web application against a current web standard.	6	5

Course Contents

Introduction to Web Applications, TCP/IP Application Services. Web Servers: Basic Operation, Virtual hosting, Chunked transfers, Caching support, Extensibility. SGML, HTML5, CSS3. XML Languages and Applications: Core XML, XHTML, XHTM MP. Web Service: SOAP, REST, WML, XSL. Web Services: Operations, Processing HTTP Requests, Processing HTTP Responses, Cooki Coordination, Privacy and P3P, Complex HTTP Interactions, Dynamic Content Delivery. Server Configuration. Server Security. Web Browsers Architecture and Processes. Active Browser Pages: JavaScript, DHTML, AJAX. JSON, Approaches to Web Application Development. Programing in any Scripting language. Search Technologies. Search Engine Optimization. XML Query Language, Semantic Web, Future Web Application Framework.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)	✓	✓		
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)			✓	
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				✓
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Web Engineering: A Practitioners' approach, Roger s. Pressman, McGraw Hill (2009)
2. JavaScript: The Definitive Guide, 8th Edition, David Flanagan. O'Reilly Media. 2014
3. Web Technologies: A Computer Science Perspective by Jeffery c. Jackson (2012)
4. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016

WEB SYSTEMS AND TECHNOLOGIES LAB

Course Code:	ITL226
Credit Hours:	1
Pre-requisite:	None

Course Objectives

The key objectives of this course include:

- To understand the basic structure of Web engineering.
- To learn the use of Web tools and develop a simple Web Application.
- To design and synthesize new techniques of Web modeling.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the design and architecture pertaining to web systems.	1	C2
2. **Demonstrate** proficiency is using different web development tools.	5	P4
3. **Design** and **implement** integrated web-based solutions following standards and best practices.	4	P4

Course Contents

Introduction to web systems and web technologies, Environment setup, HTML:HTML Tags, HTML Table, Introduction to HTML Forms, Implementing HTML buttons, lists, combo box and radio buttons; HTML 5, Canvas and webgl programing, Intro to CSS, Responsive sites and Intro to Bootstrap, Introduction to JavaScript, JavaScript: types, values, data structures, arithmetic operations, Pattern Matching, Expressions and operations, statements ,objects, local storage, functions, classes, cookies in JS, Introduction to Jquery, setup Introduction to PHP: Basic setup ,Introduction to wammp, PHP Programming: Classes, methods, arrays etc., PHP and MySQL Connectivity, Introduction to AJAX, AJAX setup, Web security, Testing Web Applications, SQL Injection, Cross side Script attack, Dos attack, Web hosting.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			✓
PLO5 (Modern Tool Usage)		✓	
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Web Engineering: A Practitioners’ approach, Roger s. Pressman, McGraw Hill (2009)
2. JavaScript: The Definitive Guide, 8th Edition, David Flanagan. O'Reilly Media. 2014
3. Web Technologies: A Computer Science Perspective by Jeffery c. Jackson (2012)
4. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016

SOFTWARE REQUIREMENT ENGINEERING

Course Code:	SEN458
Credit Hours:	3
Pre-requisite:	Software Engineering

Course Objectives

This course aims at enabling students to understand the requirements engineering process and analyze the software requirements for the development of cost-effective and efficient technical solutions. Students are expected to be able to prepare both functional and non-functional requirements and document the same in the Software Requirements Specification (SRS).

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** and explain the significance of systematic requirements engineering processes and techniques.	1	C2
2. **Employ** standard requirements engineering techniques for eliciting, analyzing, validating, and managing software requirements.	3	C3
3. **Identify and analyze** software requirements for a medium-scaled Software project.	3	C4

Course Contents

Introduction to Requirement Engineering, Software Requirements: **C**lassification of requirements, Requirements process, Levels/layers of requirements, Requirement characteristics, Analysing quality requirements, Software requirements in the context of systems engineering, Requirement evolution, requirement traceability, requirement prioritization, trade-off analysis, risk analysis and impact analysis, Requirement management, interaction between requirement and architecture, Requirement elicitation**,** elicitation sources and techniques, , Requirement specification and documentation, Requirements validation and techniques,, Management of Requirements, Introduction to Management, Requirements Management Problems, Managing Requirements in an Acquisition Organization, Supplier Organizations, Product Organizations, Requirements engineering for agile methods.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)		✓	✓
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. 1. Klaus Pohl and Chris Rupp, Requirements Engineering Fundamentals, 2nd Edition 2015, Rocky Nook Inc.
2. Elizabeth Hull, Ken Jackson and Jeremy Dick , Requirements Engineering, 3rd edition, Springer London Dordrecht Heidelberg New York.
3. Klaus Pohl and Chris Rupp, Requirements engineering fundamentals, 2nd edition, 2015 Rocky Nook Inc.
4. Wiegers, K. E. 2003. Software requirements, 2nd Edition. Redmond, Wash.: Microsoft Press,
5. Ralph R. Young, The Requirements Engineering Handbook, 2004 ARTECH HOUSE, INC.

ENTERPRISE SYSTEMS

Course Code:	ITC321
Credit Hours:	3
Pre-requisite:	Database Management Systems

Course Objectives

The key objectives of this course include familiarizing students with the fundamentals of an enterprise and its automation systems. During the course, students will also be introduced to enterprise resource planning, the technological architectures of enterprise systems, implementation methodologies and success factors and the cloud platform of ERP. Business processes and functions of enterprise systems will also be discussed.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of enterprise systems.	1	C2
2. **Elaborate** the scope of common enterprise system modules such as SCM, CRM, HRM in local and global contexts.	2	C2
3. **Implement** a strategy for selected business process(es) in enterprise systems.	4	C3
4. **Analyze** the challenges associated with the implementation of enterprise systems.	3	C4

Course Contents

Fundamentals of an Enterprise and Industries artifacts, Introduction to Enterprise Resource Planning (ERP), ERP Implementation life cycle methodologies and strategy, Business processes and architecture design, User Interface Designs and their modeling, ERP Security, workflows, data integration, applications migration and data migration, Study of business modules Human Resource, Procurement, Sales and Distribution, Material Management, and Manufacturing, Concepts and tools of designing and implementing an ERP system, Emerging trends in ERP and special topics such as Supply Chain Management (SCM), Customer Relationship Management (CRM), Business Intelligence (BI).

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)				✓
PLO4 (Design/Development of Solutions)			✓	
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Enterprise Resource Planning by Rajesh Ray, Tata McGraw Hill Education Private Limited, New Delhi, 2011
2. Design of Industrial Information Systems by Thomas O. Boucher, Ali Yalcin, Elsevier AP Printer, 2006
3. Enterprise Application Integration by David S. Linthicum, Addison Wesley Information Technology Series, 2000

IT INFRASTRUCTURE

Course Code:	ITC324
Credit Hours:	3
Pre-requisite:	None

Course Objectives

This course is aimed at introducing students to the core components of an IT infrastructure solution, such as clients, servers, network devices, operating systems, systems software, and specialized security devices. Students will also be familiarized with various aspects of IT infrastructure management and the latest trends in this area.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Understand** the key elements of an IT Infrastructure solution.	1	C2
2. **Analyze** the requirements and identify the core IT infrastructure components for a given scenario.	3	C4
3. **Appraise** the current trends in IT Infrastructure and Infrastructure Management.	2	C5
4. **Design** an IT infrastructure solution for a small organization.	4	C6

Course Contents

Definition of IT Infrastructure, Non-functional Attributes, Availability Concepts, Sources of Unavailability, Availability Patterns. Performance. Security Concepts. Data centers. Servers: Availability, Performance, Security. Networking: Building Blocks, Availability, Performance, Security. Storage: Availability, Performance, Security. Virtualization: Availability, Performance, Security. Operating Systems: Building Blocks, Implementing Various OSs, OS availability, OS Performance, OS Security. End User Devises: Building Blocks, Device Availability, Performance, Security. IT Infrastructure Management. Service Delivery Processes. Service Support Processes. Ethics, Trends, organizational and technical issues related to IT infrastructure.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)			✓	
PLO3 (Problem Analysis)		✓		
PLO4 (Design/Development of Solutions)				✓
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. IT Infrastructure Architecture: Infrastructure building blocks and concepts by Sjaak Laan, Lulu.com (November 5, 2011). ISBN-10: 1447881281
2. IT Infrastructure and its Management by Prof Phalguni Gupta, Tata McGraw Hill Education Private Limited (October 6, 2009). ISBN-10: 0070699798
3. IT Architecture for Dummies by Kalani Kirk Hausman and Susan Cook, For Dummies; 1st Edition (November 9, 2010). ISBN-10: 0470554231.

TECHNICAL WRITING AND PRESENTATION SKILLS

Course Code:	HSS320
Credit Hours:	3
Pre-requisite:	Communication Skills

Course Objectives

The main objective of this course is to develop effective writing and presentation skills in students. After learning effective data gathering, interpreting and presentation skills, students will be able to write clear, persuasive, and accessible documents for intended audiences. Furthermore, this course aims to develop textual, linguistic and presentation competencies in students appropriate for their professional careers.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an appropriate communication style to different types of audiences in an ethically responsible manner.	9	A2
2. **Demonstrate** competence in producing technical documents.	7	A3
3. **Work** on a standard word processing software along with a referencing tool for writing technical reports.	5	P4
4. **Present** topics using modern presentation skills and demonstrate a thorough understanding of verbal and non-verbal communication.	7	A3

Course Contents

Introduction to Technical Writing: Definition & Scenarios, Importance Of Technical Writing, Teamwork, 21st-Century Business Management Philosophies, Conflict Resolution in Team Meeting, Strategies For Successful Collaboration, Producing the Product, The Writing Process: An Overview, Prewriting, Writing, Rewriting, The Process In Practice, Objectives in Technical Writing, Writing at Work: Clarity, Conciseness, Accuracy, Organization, Ethics, Audience Recognition and Involvement, Audience Recognition, Defining Terms for Different Audience Levels, Biased Language- Issues of Diversity, Multiculturalism, Research: Criteria for Writing Research Reports, Process, Plagiarism, The Summary: Criteria for Writing Summaries, Process, Process Log, Reports, Reports: Criteria For Writing Reports, Types Of Reports, Trip Report, Progress Report, Lab Report, Feasibility Report, Incident Report, Investigation Report, Meeting Minutes, Proposals:, Writing At Work, Criteria For Proposals, Process, Sample External and Internal Proposals, Oral Communication: Everyday Oral Communication, Telephone And Voice Mail, Informal Oral Presentations, Oral Communication, Formal Presentations, Parts Of a Formal Oral Presentation, Visual Aids, PowerPoint Presentations, The Writing Process, The Job Search: Objectives, How To Find Job Openings, Criteria For Effective Resumes, Methods Of Delivery, Sample Resumes, Criteria For Effective Letters Of Application, Techniques For Interviewing Effectively, Criteria For Effective Follow-Up Correspondence, Sample Follow-Up Letter, Checklists, Technical Description, Types Of Technical Description, Criteria For Writing Technical Descriptions:

Process, Process Log, Sample Technical Description, Instructions And User Manuals: Criteria For Writing Short Instructions, Process, Process Log, Sample Short Instructions.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)			✓	
PLO6 (Individual and Teamwork)				
PLO7 (Communication)		✓		✓
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)	✓			
PLO10 (Life-long Learning)				

Resources

1. Sharon J. Gerson, Steven M. Gerson ,"Technical Writing Process and Product", Fifth Edition
2. Diana G. Creep ,“Technical Writing principals, strategies, and readings", Fourth Edition
3. "Microsoft Manual of Style for Technical Publications", Microsoft Press, Third Edition
4. St. Martin's, Mike Marke ,"Technical Communication", Bedford, Eighth Edition

CYBER SECURITY	
Course Code:	ITC411
Credit Hours:	3
Pre-requisite:	Data Communication and Networking

Course Objectives

This course provides students an introduction to common cyber security threats, vulnerabilities, and risks related to web applications, networks, software and mobile applications. The course provides basic concepts and terminology used in the information and cyber security fields. Moreover, it will also enable students to differentiate between the various forms of malware and how they affect computers and networks.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Identify** various computer system threats.	1	C2
2. **Identify** Malware attacks and understand the stages of attack and payloads.	2	C2
3. **Implement** various cryptographic techniques and simulate attack scenarios.	5	C3
4. **Generate** and **analyze** reports based on digital forensic tools for security systems and platforms.	5	C4

Course Contents

Introduction to Cyber security; Networks and the Internet; cyber threat landscape; understanding security; information security Principles (Confidentiality, Integrity, Availability); Information Security Terminology; Who are the attackers; Advanced Persistent Threat (APT); Malware, types of malware; Attacks using malware; Malware Attack Lifecycle: Stages of Attack; Social engineering attacks; types of payload; Industrial Espionage in Cyberspace; Basic cryptography; Web application attacks; Database security; Cyber kill chain; Privacy and anonymity; Network security; Software security; Mobile device security; Mobile app security; Cyber Terrorism and Information Warfare; Introduction to Digital Forensics; Digital Forensics Categories.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)			✓	✓
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				
PLO10 (Life-long Learning)				

Resources

1. Computer Security Fundamentals by Chuck Easttom, 4th edition or Latest.
2. Security+ Guide to Network Security Fundamentals, by Mark Ciampa, 5th Edition.
3. Security in Computing by C.P. Pfleeger, Prentice-Hall, 4th Edition or Latest.

DATABASE ADMINISTRATION AND MANAGEMENT

Course Code:	ITC424
Credit Hours:	3
Pre-requisite:	Database Management Systems

Course Objectives

The objective of this course is to provide students with the opportunity to build upon the knowledge of Database Management Systems and prepare them for database administration. Students will be introduced to the management of database services and clients along with the implementation and configuration of a database environment. Database optimization, maintenance and recovery procedures will also be discussed.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Explain** the advanced data models such as object-relational and object-oriented models.	1	C2
2. **Implement** the user roles and associated permissions as per the computing practices.	2	C3
3. **Analyze** file organization techniques to optimize memory allocation of databases.	3	C4
4. **Identify** and **assess** the ethical considerations to ensure the integrity and security of databases.	9	C5

Course Contents

Introduction to advanced data models such as object relational, object oriented, File organizations concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing and optimization, Database Programming, Integrity and security, Database Administration, Physical database design and tuning, Distributed database systems, Emerging research trends in database systems.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3	CLO4
PLO1 (Academic Education)	✓			
PLO2 (Knowledge for Solving Computing Problems)		✓		
PLO3 (Problem Analysis)			✓	
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)				
PLO9 (Ethics)				✓
PLO10 (Life-long Learning)				

Resources

1. Fundamentals of Database Systems, by Ramez Elmasri and Shamkant Navathe, Addison Wesley, 5th Edition.
2. Database System Concepts by Henry F. Korth and Abraham Silberschatz, 4th edition, McGraw Hill, 2002, ISBN: 0-07-12268-0

DATABASE ADMINISTRATION AND MANAGEMENT LAB

Course Code:	ITL424
Credit Hours:	1
Pre-requisite:	Database Management Systems

Course Objectives

This course is aimed at introducing students to the set of activities performed by a database administrator including query optimization, user management, database security, database monitoring, backup and recovery and database migration.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	**PLO**	**BT Level**
1. **Implement** query optimization and file organization techniques.	5	P4
2. **Define** and **apply** user roles and permissions.	8	P4
3. **Manage** large databases within an enterprise.	10	P5

Course Contents

Recap of SQL Queries + Joins + Attributes, Database Optimization, SQL Queries Optimization, File organization, Users Management and role management, Database system queries, System Stored Procedures and User defined Stored Procedures, T-SQL Loops and Cursors, Triggers, DML log management, Transactions and Dead Lock & Recovery, Database Scripting, Databases Backup & Recovery, Disaster Recovery Planning, Database Migration.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)	✓		
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)		✓	
PLO9 (Ethics)			
PLO10 (Life-long Learning)			✓

Resources

1. Fundamentals of Database Systems, by Ramez Elmasri and Shamkant Navathe, Addison Wesley, 5th Edition.
2. Database System Concepts by Henry F. Korth and Abraham Silberschatz, 4th edition, McGraw Hill, 2002, ISBN: 0-07-12268-0

PAKISTAN STUDIES

Course Code:	PAK101
Credit Hours:	2
Pre-requisite:	None

Course Objectives

The course "Pakistan Studies" is aimed to impart knowledge about the reason of development, vision and history of Pakistan to the students. It will cover the era ranging from pre-development to the post-development of Pakistan and highlight the great sacrifices made by the leaders of the Islamic State Pakistan. This course will help students develop a sense of patriotism as well as an urge for creative reconstruction. It will seek to cover Pakistan's Cultural Heritage since ancient times, Muslim Political Thought over the centuries, Constitutional Development since 1947, Political Systems and their functioning, Public Policies and Reforms, Agro-Industrial Projects, Urbanization, Social change and Transformation, Political Development

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of political and constitutional system of Pakistan	8	C2
2. **Understand** the social, moral, and cultural values system of Pakistan.	9	C2
3. **Analyze** the contemporary problems faced by Pakistan (social, human resource, economic development, food safety / water resources)	8	C4
4. **Develop** an understanding and appreciation for patriotism and loyalty towards national interest.	10	C4

Course Contents

Historical background of Pakistan: Muslim society in Indo-Pakistan, the movement led by the societies, the downfall of Islamic society, the establishment of British Raj- Causes and consequences. Political evolution of Muslims in the twentieth century: Sir Syed Ahmed Khan; Muslim League; Nehru; Allama Iqbal, Independence Movement; Lahore Resolution; Pakistan culture and society, Constitutional and Administrative issues, Political and Constitutional development of Pakistan, Pakistan and its geopolitical dimension, Pakistan and International Affairs, Pakistan and the challenges ahead. Viable political order and the contemporary issues, social issues, environmental issues, economics disparity, attention required at the current local and global issues like global warming.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**	**CLO4**
PLO1 (Academic Education)				
PLO2 (Knowledge for Solving Computing Problems)				
PLO3 (Problem Analysis)				
PLO4 (Design/Development of Solutions)				
PLO5 (Modern Tool Usage)				
PLO6 (Individual and Teamwork)				
PLO7 (Communication)				
PLO8 (Computing Professionalism and Society)	✓		✓	
PLO9 (Ethics)		✓		
PLO10 (Life-long Learning)				✓

Resources

1. The Emergence of Pakistan, Chaudary M., 1967
2. The making of Pakistan, Aziz. 1976 3. A Short History of Pakistan, I. H. Qureshi, ed., Karachi, 1988
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

ISLAMIC STUDIES

Course Code:	ISL101
Credit Hours:	2
Pre-requisite:	None

Course Objectives

This course is aimed to enhance understanding of students regarding concepts of faith and ehkam, ahadees and sunnah and compare with modern day living. It is also focused to enhance understanding of the students regarding Islamic Ethics, laws, culture, civilization, and contemporary issues. Moreover, to enhance the skills of students for understanding Islamic Architecture, its forms, styles, elements and an introduction to Muslim Architects.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** the understanding of fundamental human rights and relation with non-Muslims through discussion on related issues.	9	C2
2. **Demonstrate** knowledge of Islamic civilization and moral values.	10	C2

Course Contents

Basic Themes of Quran, Introduction to Sciences of Hadith, Introduction to Islamic Jurisprudence, Primary & Secondary Sources of Islamic Law, Makken & Madnian life of the Prophet, Islamic Economic System, Political theories, Social System of Islam, Introduction to Quranic Studies, Basic Concepts of Quran, History of Quran, Uloom-ul –Quran, Basic Quranic Teachings of Faith related to Surah Baqarah Verse 284-286, Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11), Faith on the Day of Judgment with Verses of Surah AlHashar (18,19,20) Related to Day of Judgment, Seerah of Holy Prophet (S.A.W)-I, Important Events with Lessons Derived from the life of Holy Prophet in Makkah, Basic Quranic Teachings of Adab-e-Nabi relate to Surah Al-ahzab, Seerah of Holy Prophet (S.A.W) – II, Important Events with Lessons Derived from the life of Holy Prophet (S.A.W) in Madina, Quranic Teachings of Adab Al-Nabi related to Surah Al Hujrat Verse 1-3, Introduction to Hadith, Basic Concepts of Hadith, History of Hadith, Kinds of Hadith

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**
PLO1 (Academic Education)		
PLO2 (Knowledge for Solving Computing Problems)		
PLO3 (Problem Analysis)		
PLO4 (Design/Development of Solutions)		
PLO5 (Modern Tool Usage)		
PLO6 (Individual and Teamwork)		
PLO7 (Communication)		
PLO8 (Computing Professionalism and Society)		
PLO9 (Ethics)	✓	
PLO10 (Life-long Learning)		✓

Resources

1. Introduction to Islam by Dr Hamidullah, Papular Library Publishers Lahore
2. Principles of Islamic Jurisprudence by Ahmad Hassan, Islamic Research Institute, IIUI
3. Muslim Jurisprudence and the Quranic Law of Crimes, By Mir Waliullah, Islamic Books Services

VIRTUAL SYSTEMS AND SERVICES

Course Code:	ITC422
Credit Hours:	3
Pre-requisite:	Operating Systems

Course Objectives

This course is aimed at introducing students to virtualization in computing systems. Students will learn the principles of virtualization technologies and the concepts how virtual machines, hypervisors, virtual networks, and virtual storage work together. Students will also be introduced to different approaches in virtual machine management and troubleshooting.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Demonstrate** an understanding of the key concepts of virtual machines and virtualization in computing systems.	1	C2
2. **Understand** virtual networks and storage.	2	C2
3. **Deploy** and **manage** virtual machines.	5	C3

Course Contents

Introduction to Virtualization: Current state of virtualization in computing systems Physical and virtual machines, Traditional and virtual computing, Understanding virtualization, Need and Applications of virtualization, Limitations, Simulations and Emulations, Challenges in Virtualized environment, tools and technologies in virtualized environments, Types of Virtualization: Various forms of virtualization: Desktop, Application, Server, Hardware, Storage, Memory and I/O virtualization, VM Management, Storage virtualization: RAID, SCSI, iSCSI, Direct attached storage, Network Attached storage, Storage Area network, Virtualization performance and Security, Case Studies.

Mapping of CLOs to PLOs

PLOs/CLOs	**CLO1**	**CLO2**	**CLO3**
PLO1 (Academic Education)	✓		
PLO2 (Knowledge for Solving Computing Problems)		✓	
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)			✓
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			

Resources

1. Handbook of Virtual Environments: Design, Implementation, and Applications (Human Factors and Ergonomics), Edited by Kay M Stanney, Lawrence Erlbaum Associates Virtual Reality Technology by GRIGORE
2. Chris Wolf and Erick M. Halter, “Virtualization” A press; 1 edition 2005.
3. Edward Haletky, “VMware ESX and ESXi in the Enterprise – Planning Deployment of Virtualization Servers” [ISBN: 978-0137058976]., Prentice Hall; 2 edition February 18, 2011.
4. LatifaBoursas (Editor), Mark Carlson (Editor), Wolfgang Hommel (Editor), Michelle Sibilla (Editor), KesWold (Editor), “Systems and Virtualization Management: Standards and New Technologies”, October 14, 2008.

Bahria University
Discovering Knowledge

VIRTUAL SYSTEMS AND SERVICES LAB

Course Code:	ITL422
Credit Hours:	1
Pre-requisite:	Operating Systems

Course Objectives

This course is aimed at introducing students to virtualization in computing systems. Students will learn the principles of virtualization technologies and the concepts how virtual machines, hypervisors, virtual networks, and virtual storage work together. Students will also be introduced to different approaches in virtual machine management and troubleshooting.

Course Learning Outcomes

After successful completion of this course, the students should be able to:	PLO	BT Level
1. **Install** and **configure** virtualization technology such as VMware.	5	P4
2. **Configure** and **manage** virtual network and storage.	5	P4
3. **Implement** private cloud platform using virtualization and **use** virtual machines of public cloud platform.	10	P5

Course Contents

Familiarization with different types of virtualization and the environments that support them, f server and desktop based virtualization, Configuration processes of server virtualization. Creating a virtual machine, installing a guest operating system in a virtual machine, Installing VMware Tools on a virtual machine, Creating Private cloud using Virtualization tool and working with virtual machine in public cloud, implementing storage virtualization, Configuring and managing virtual networking, Virtual machine migration and cloning.

Mapping of CLOs to PLOs

PLOs/CLOs	CLO1	CLO2	CLO3
PLO1 (Academic Education)			
PLO2 (Knowledge for Solving Computing Problems)			
PLO3 (Problem Analysis)			
PLO4 (Design/Development of Solutions)			
PLO5 (Modern Tool Usage)	✓	✓	
PLO6 (Individual and Teamwork)			
PLO7 (Communication)			
PLO8 (Computing Professionalism and Society)			
PLO9 (Ethics)			
PLO10 (Life-long Learning)			✓

Resources

1. Handbook of Virtual Environments: Design, Implementation, and Applications (Human Factors and Ergonomics), Edited by Kay M Stanney, Lawrence Erlbaum Associates Virtual Reality Technology by GRIGORE
2. Chris Wolf and Erick M. Halter, “Virtualization” A press; 1 edition 2005.
3. Edward Haletky, “VMware ESX and ESXi in the Enterprise – Planning Deployment of Virtualization Servers” [ISBN: 978-0137058976]., Prentice Hall; 2 edition February 18, 2011.
4. LatifaBoursas (Editor), Mark Carlson (Editor), Wolfgang Hommel (Editor), Michelle Sibilla (Editor), KesWold (Editor), “Systems and Virtualization Management: Standards and New Technologies”, October 14, 2008.
5. **Tools:** Xen, VMWare, Hyper-V etc.

Appendage 2507

a) Following lab codes are inconsistent with courses and need revision. Suggested codes for approval are also presented.

Course	Credit hours	Suggested code	Remarks
Applied Physics Lab	1	GSL 114	lab code missing for 2+1 course
Computer organization and Assembly Language Lab	1	CEL 324	lab code missing for 3+1 course
Artificial Intelligence Lab	1	CSL 325	lab code missing for 3+1 course
Robotics Lab	1	CEL 459	lab code missing for 2+1 course
Digital Image Processing lab	1	CEL 445	lab code missing for 2+1 course
Digital Signal processing Lab	1	EEL 326	lab code missing for 2+1 course

Microprocessor and Interfacing Lab	1	CEL 320	lab code missing for 2+1 course
Signals and systems lab	1	EEL 314	lab code missing for 2+1 course

b) Following courses of BS(IT) program have codes greater than 600 listed in UCC and need revision.

Business process reengineering	3	ITC 425	ITC 625 is listed in code book
Knowledge Management System and Technologies	3	ITC 457	ITC 657 is listed in code book

c) Following courses need to be added in the list of electives for BS(CS):

- Software Quality Assurance
- Software Testing

d) Following courses need to be added in the list of electives for BS(IT):

- Cloud Computing
- Big Data Analytics
- Introduction to Data Science
- Multimedia Systems
- Human Computer Interaction

Appendage 2508

BS (CS) CLOs with Cognitive Levels								
S No.	**Course Code**	**Course Title**	**CLO**	**Descrription of CLO**	**Mapped PLO**	**Domain**	**Skill Level**	**Comments by BUKC**
1	GSC 110	Applied Calculus and Analytical Geometry	CLO1	Describe real value functions of one and more variables	PLO1:Academic Education	Cognitive	1	
			CLO2	Apply the concepts of limits and continuity to solve	PLO3:Problem Analysis	Cognitive	3	merge clo2 and clo33

				problems in differential calculus				
			CLO3	Solve applied problems by applying concepts of Integration	PLO3:Problem Analysis	Cognitive	3	
2	CSC 114	Introduction to Information & Communication Technology	CLO 1	Describe the components of a computer system	PLO1:Academic Education	Cognitive	1	
			CLO 2	Understand the fundamentals of operating systems, databases, and number systems	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO 3	Explain Networking and Internet Technologies	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	bt level change c2 to c3
3	CSL 114	Introduction to Information & Communication Technology Lab	CLO 1	Observe the operations of various components of computing system	PLO1:Academic Education	Psychomotor	1	chnage wording of clo1
			CLO 2	Practice the basic computer application software like MS Word, MS Excel, MS Power Point, MS Access etc.	PLO5:Modern Tool Usage	Psychomotor	3	
			CLO 3	Demonstrate the use of communication and networking	PLO6:Individual and Team Work	Psychomotor	4	hange plo 6 to plo4

4	ENG 105	Functional English	CLO1	Demonstrate English listening skills to function successfully in target language listening situation.	PLO7:Communication	Affective	1	
			CLO2	Exhibit English reading skills to comprehend various aspects of the nature of the reading material.	PLO7:Communication	Affective	1	
			CLO3	Practice English speaking skills to express effectively through speech.	PLO7:Communication	Affective	2	
			CLO4	Demonstrate formal and informal English writing skills to express ideas and convey message to target readers.	PLO7:Communication	Cognitive	3	
5	CSC 113	Computer Programming	CLO1	Demonstrate the understanding of the basic concepts of programming	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	change plo2 to 1 of clo1
			CLO2	Exhibit logic building ability using basic	PLO3:Problem Analysis	Cognitive	2	change btl to c4 of clo2, change plo3 to plo2 of clo2,analyze instead of exhibit

				programming concepts				
			CLO3	Apply programming concepts to model requirements and solve simple computing problems using a high level programming language	PLO4:Design and Development of Solutions	Cognitive	3	change plo4 to plo3 of clo3
6	CSL 113	Compute r Program ming Lab	CLO1	Demonstrate the understandin g of programing language syntax and its usage	PLO2:Knowledge for Solving Computing Problems	Psychomot or	2	
			CLO2	Apply basic programming structures for logic construction	PLO3:Problem Analysis	Psychomot or	3	
			CLO3	Translate the devised solutions into computer programs and test the implementati on	PLO5:Modern Tool Usage	Psychomot or	3	implement instead of translate.
7	GSC 114	Applied Physics	CLO1	Comprehend the working knowledge of fundamental laws of physics.	PLO1:Academic Education	Cognitive	2	rephrase clo 1 & clo2
			CLO2	Apply the knowledge of fundamental laws to solve various real world problems	PLO1:Academic Education	Cognitive	3	change plo1 to plo2 of clo2

			CLO3	Analyze different physical problems using the knowledge gained from different areas like electromagnetism, optics etc.	PLO3:Problem Analysis	Cognitive	4	
8	GSL 114	Applied Physics Lab	CLO1	Develop the ability to record readings using different measurements tools.	PLO5:Modern Tool Usage	Psychomotor	3	
			CLO2	Demonstrate an understanding of basic laws of Physics through relevant experimentation.	PLO6:Individual and Team Work	Psychomotor	4	
			CLO3	Show knowledge of constructing an electronic circuit for a given set of constraints.	PLO3:Problem Analysis	Psychomotor	5	
9	HSS 120	Communication Skills	CLO1	Participate actively in group discussions by exercising attentive listening and constructive debate.	PLO6:Individual and Team Work	Affective	2	
			CLO2	Initiate a conversation and	PLO7:Communication	Affective	3	

				communicate effectively by employing intermediate to advanced level English vocabulary.				
			CLO3	Express or present ideas independently in front of an audience and effectively respond to queries.	PLO7:Communication	Affective	3	
			CLO4	Learn strategies to manage apprehension before public speaking; and to implement vocal and physical behaviors to support communication;	PLO10:Life Long Learning	Cognitive	3	
10	CSC 210	Object Oriented Programming	CLO1	Develop an understanding of the underlying concepts of object oriented paradigm	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply object oriented concepts in solving computing problems	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Design and implement object oriented solutions for small real world	PLO4:Design and Development of Solutions	Cognitive	4	

				problems including single/multiple objects				
			CLO4	Evaluate the workflow of an object oriented solution including error handling	PLO4:Design and Development of Solutions	Cognitive	5	
11	CSL 210	Object Oriented Programming Lab	CLO1	Demonstrate an understanding of object oriented design concepts and their mapping to object oriented programming	PLO4:Design and Development of Solutions	Psychomotor	3	
			CLO2	Implement and debug object oriented solutions for problems involving multiple classes	PLO5:Modern Tool Usage	Psychomotor	4	
			CLO3	Demonstrate effective communication and teamwork	PLO6:Individual and Team Work	Affective	2	
12	CEN 120	Digital Logic Design	CLO1	Understanding of the Boolean Algebra, Boolean Functions, Combinational and Sequential Logic and PLDs	PLO1:Academic Education	Cognitive	2	

			CLO2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	change clo2 to clo3 of clo3 and change
			CLO3	Design the combinational and synchronous sequential circuits under given scenario	PLO3:Problem Analysis	Cognitive	2	rephrase clo3, plo3 to plo4
13	CEL 120	Digital Logic Design Lab	CLO1	Understand the tools and techniques for the design of digital electronic circuits	PLO1:Academic Education	Cognitive	2	change bt level c2 to PMotor(p1) of clo1.
			CLO2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	PLO2:Knowledge for Solving Computing Problems	Psychomotor	3	
			CLO3	Apply the acquired knowledge to simulate and implement small scale digital circuits	PLO3:Problem Analysis	Psychomotor	4	change p4 to p5 of clo3
14	GSC 221	Discrete Mathematics	CLO1	Demonstrate an understanding of the key concepts of	PLO1:Academic Education	Cognitive	2	

				Discrete Structures				
			CLO2	Relate various discrete structures with different areas of Computer Science	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real world problems.	PLO3:Problem Analysis	Cognitive	3	
			CLO4	Develop pseudocodes of algorithms for standard computing problems	PLO4:Design and Development of Solutions	Cognitive	3	remove clo4
15	GSC 122	Probability and Statistics	CLO1	Explain and express the basic understanding of probability and statistics.	PLO1:Academic Education	Cognitive	2	
			CLO2	Demonstrate an ability to use descriptive techniques to describe the statistical data.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Apply inferential statistical methods to solve problems.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO4	Analyze and investigate any given	PLO3:Problem Analysis	Cognitive	4	

				data distribution.				
16	GSC 211	Multivariable Calculus	CLO1	Comprehend the basic concepts and techniques of differential and integral calculus of functions of several variables.	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply the knowledge of different transforms to solve relevant problems.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Analyze the given problems and apply integrals to compute the area/volume.	PLO3:Problem Analysis	Cognitive	4	
17	CEN 325	Computer Organization& Assembly Language	CLO1	Identify the major components of computer architecture, and explain their purposes and interactions	PLO1:Academic Education	Cognitive	2	interpret instead of stimulate.change bt level to c3 to c2 of clo1
			CLO2	Simulate the internal representation of data, and show how data is stored and accessed in, I/O modules, and the interconnecting components of the	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	

				computer systems				
			CLO3	Analyze the relationships between hardware architecture and its instruction set.	PLO3:Problem Analysis	Cognitive	4	
18	CEL 325	Computer Organization& Assembly Language Lab	CLO1	Acquire the basic knowledge of computer organization, computer architecture and assembly language	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	understand instead of acquire
			CLO2	Implement the arithmetic logical operation using Instruction set architecture (ISA) at ALU & memory units	PLO3:Problem Analysis	Psychomotor	3	
			CLO3	Solve the problems related to computer organization and assembly language	PLO3:Problem Analysis	Psychomotor	4	
19	CSC 221	Data Structure & Algorithms	CLO1	Explain and compare different data structures and their applications	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply appropriate data structures	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	

				according to the given scenarios and application domain				
			CLO3	Analyze time complexity of different algorithms	PLO2:Knowledge for Solving Computing Problems	Cognitive	4	CHANGE plo2 to plo3 of clo3
			CLO4	Design efficient algorithm(s) to solve real world problems	PLO4:Design and Development of Solutions	Cognitive	6	eliminate C4
20	CSL 221	Data Structures and Algorithms Lab	CLO1	Implement different linear and non linear data structures	PLO3:Problem Analysis	Psychomotor	3	
			CLO2	Construct programs for problems and application domain by using appropriate data structures.	PLO4:Design and Development of Solutions	Psychomotor	4	
			CLO3	Demonstrate effective teamwork in solving problems	PLO6:Individual and Team Work	Affective	2	
21	CSC 307	Professional Practices	CLO1	Identify the content of religious, national, or international law dealing with professional ethics	PLO8:Computing Professionalism and Society	Affective	2	
			CLO2	Apply the knowledge of ethics in their personal and	PLO9:Ethics	Affective	3	

				professional life				
			CLO3	Gain the ability to enhance key factors of interpersonal relations, to follow and implement the acquired knowledge of ethical skills in given situations by controlling his/her temperamen t.	PLO10:Life Long Learning	Affective	4	
22	CSC 321	Design and Analysis of Algorithm s	CLO1	Demonstrate an understandin g of algorithm design process and different problem solving techniques	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO2	Analyze the time and space complexity of different algorithms.	PLO3:Problem Analysis	Cognitive	4	
			CLO3	Design algorithms to solve simple computation al problems and compare the implementati ons empirically	PLO4:Design and Development of Solutions	Cognitive	6	
23	CSC 220	Database Manage	CLO1	Explain the fundamental	PLO2:Knowledge for Solving	Cognitive	2	

		ment Systems		concepts of databases	Computing Problems			
			CLO2	Apply different database models to design conceptual, logical, and physical databases	PLO4:Design and Development of Solutions	Cognitive	3	
			CLO3	Apply queries to extract information from databases	PLO5:Modern Tool Usage	Cognitive	3	eliminate clo3
			CLO4	Analyze user requirements to design a database for the given scenarios	PLO4:Design and Development of Solutions	Cognitive	4	
24	CSL 220	Database Manage ment Systems Lab	CLO1	Practice writing SQL commands to perform different tasks	PLO4:Design and Development of Solutions	Psychomot or	3	clo1 should be rephrase
			CLO2	Make ER diagrams as to analyze and interpret data design of database	PLO3:Problem Analysis	Psychomot or	4	remove make ER diagrams as from clo2
			CLO3	Make a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and	PLO5:Modern Tool Usage	Psychomot or	4	design instead of make in clo3

				implementing a DBMS				
25	CSC 315	Theory of Automata	CLO1	Explain the different concepts in automata theory and formal languages.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO2	Analyze properties of languages, grammars, and automata with formal methods.	PLO3:Problem Analysis	Cognitive	4	
			CLO3	Design grammars and models for different languages.	PLO4:Design and Development of Solutions	Cognitive	5	
26	GSC 210	Differential Equations	CLO1	Comprehend the fundamental concepts of differential equations.	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply different methods of solving 1st and 2nd order ordinary differential equations.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Solve Partial derivatives in different coordinate systems.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO4	Analyze and subsequently solve physical situations whose behavior can be described	PLO3:Problem Analysis	Cognitive	4	

				by ordinary/partial differential equations.				
27	CSC 320	Operating Systems	CLO1	Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply the concepts of memory management, I/O management CPU management and processor management etc.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Analyze the algorithms of the core functions of Operating Systems and explain the major performance issues with respect to the core functions.	PLO3:Problem Analysis	Cognitive	4	
28	CSL 320	Operating Systems Lab	CLO1	Implement OS concepts like those of shell scripting,	PLO3:Problem Analysis	Psychomotor	2	

				processes, file manipulation and inter-processes communication				
			CLO2	Demonstrate the knowledge in applying system software and tools available in modern operating systems	PLO5:Modern Tool Usage	Psychomotor	4	
29	SEN 220	Software Engineering	CLO1	Describe various software engineering processes and activities	PLO1:Academic Education	Cognitive	1	
			CLO2	Apply knowledge of software engineering appropriate to the discipline, particularly in the modeling, design, testing and deployment of software systems.	PLO4:Design and Development of Solutions	Cognitive	3	clo2 map to plo2 instead of plo4
			CLO3	Analyze and solve small scale Software Engineering problems	PLO3:Problem Analysis	Cognitive	4	
30	CSC 323	Compiler Construction	CLO1	Understand the basic techniques used in	PLO1:Academic Education	Cognitive	2	

				compiler construction such as lexical analysis, top-down, bottom-up parsing, context-sensitive analysis, and intermediate code generation.				
			CLO2	Explain the basic data structures used in compiler construction such as abstract syntax trees, symbol tables, three-address code, and stack machines etc.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	redesign/rephrase clo3 & clo2
			CLO3	Design and implement a compiler using a software engineering approach	PLO4:Design and Development of Solutions	Cognitive	3	
			CLO4	Select and employ appropriate code generation and optimization techniques	PLO5:Modern Tool Usage	Cognitive	4	Eliminate clo 4
31	CSL 323	Compiler Construction Lab	CLO1	Apply various techniques to implement the lexical module, symbol table	PLO2:Knowledge for Solving Computing Problems	Psychomotor	3	

				and syntax analyzer of a compiler.				
			CLO2	Implement different code generation techniques.	PLO2:Knowledge for Solving Computing Problems	Psychomotor	3	eliminate clo2
			CLO3	Demonstrate the ability to design and implement a simple simulation of a compiler.	PLO4:Design and Development of Solutions	Psychomotor	4	
32	GSC 121	Linear Algebra	CLO1	Interpret the fundamental concepts of linear algebra, vector equations and linear transformations.	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply the basic knowledge of vector spaces, eigen value and eigen vectors to solve the critical problems of Linear Algebra	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Solve systems of linear equations appearing in different engineering applications	PLO3:Problem Analysis	Cognitive	3	
33	CEN 222	Data Communication and	CLO 1	Understand basic principles and	PLO1:Academic Education	Cognitive	2	

		Networking		functionalities of Data Communication and Networks.				
			CLO 2	Explain the services and functions provided by each layer in the Internet protocol stack.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO 3	Identify various internetworking devices and protocols, and their functions in a network.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
34	CEL 222	Data Communication and Networking Lab	CLO 1	Make different cable types.	PLO1:Academic Education	Psychomotor	2	demonstrate instead of make in clo1,change plo1 to plo3 of clo1
			CLO 2	Apply and simulate different routing protocols like RIP, OSPF, NAT and ACL.	PLO5:Modern Tool Usage	Psychomotor	3	
			CLO 3	Build Computer Network (s) on various topologies.	PLO6:Individual and Team Work	Psychomotor	3	
35	ISL 101	Islamic Studies / Ethics	CLO1	Demonstrate the understanding of fundamental human rights and relation with non Muslims through	PLO9:Ethics	Cognitive	2	

				discussion on related issues				
			CLO2	Demonstrate knowledge of Islamic civilization and moral values	PLO10:Life Long Learning	Cognitive	2	
36	CSC 412	Artificial Intelligence	CLO 1	Understand key components in the field of artificial intelligence	PLO1:Academic Education	Cognitive	2	
			CLO 2	Implement classical artificial intelligence techniques	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	explain instead of implement in clo2
			CLO 3	Appraise real world problems for machine learning based solutions	PLO3:Problem Analysis	Cognitive	4	eliminate clo3
			CLO 4	Apply knowledge representation and inference techniques for practical problem solving.	PLO4:Design and Development of Solutions	Cognitive	3	
37	CSL 412	Artificial Intelligence Lab	CLO 1	Demonstrate proficiency in developing AI applications in LISP and Prolog	PLO5:Modern Tool Usage	Psychomotor	3	
			CLO 2	Apply basic principles of AI in solutions that require problem solving, inference,	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	

				perception, knowledge representation, and learning				
			CLO 3	Demonstrate proficiency in developing and applying models of machine learning	PLO4:Design and Development of Solutions	Cognitive	3	rephrase clo3,change bt level c3 to p5 of clo3
38	GSC 320	Numerical Analysis	CLO1	Demonstrate the understanding of common numerical methods.	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply typical numerical approaches, errors, to compute approximate solutions to Mathematical problems.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Evaluate numerical methods for a variety of Mathematical processes and problems, including integration and differentiation.	PLO3:Problem Analysis	Cognitive	5	
			CLO4	Develop numerical methods using a programming language.	PLO2:Knowledge for Solving Computing Problems	Cognitive	6	
39	HSS 320	Technical Writing and	CLO1	Demonstrate an appropriate	PLO9:Ethics	Affective	2	

		Presentation Skills		communication style to different types of audiences in an ethically responsible manner.				
			CLO2	Demonstrate competence in producing technical documents	PLO7:Communication	Affective	3	
			CLo3	Work on a standard word processing software along with a referencing tool for writing technical reports.	PLO5:Modern Tool Usage	Psychomotor	4	
			CLO4	Present topics using modern presentation skills and demonstrate a thorough understanding of verbal and non verbal communication.	PLO7:Communication	Affective	3	
40	CEN 455	Parallel & Distributed Computing	CLO1	Demonstrate an understanding of parallel and distributed computers	PLO1:Academic Education	Cognitive	2	
			CLO2	Write portable programs for parallel or distributed	PLO4:Design and Development of Solutions	Cognitive	3	change bt level c3 to c5 of clo2

				architectures using Message Passing Interface (MPI) library				
			CLO3	Analyze complex problems with shared memory programming with OpenMP	PLO3:Problem Analysis	Cognitive	4	
41	PAK 101	Pakistan Studies	CLO1	Demonstrate the understanding of political and constitutional system of Pakistan	PLO8:Computing Professionalism and Society	Cognitive	2	
			CLO2	Understand the social, moral and cultural values system of Pakistan.	PLO9:Ethics	Cognitive	2	
			CLO3	Analyze the contemporary problems faced by Pakistan (social, human resource, economic development, food safety / water resources)	PLO8:Computing Professionalism and Society	Cognitive	4	
			CLO4	Develop an understanding and appreciation for patriotism and loyalty towards	PLO10:Life Long Learning	Cognitive	4	

				national interest.				
42	CSC 407	Information Security	CLO1	Explain key concepts of information security such as design principles, cryptography, risk management, and ethics.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO2	Apply various security and risk management tools for achieving information security and privacy.	PLO5:Modern Tool Usage	Cognitive	3	
			CLO3	Identify appropriate techniques to tackle and solve problems in the discipline of information security.	PLO3:Problem Analysis	Cognitive	4	
			CLO4	Create solutions to real life scenarios using different security related tools.	PLO4:Design and Development of Solutions	Cognitive	6	eliminate clo4
43		Final Year Project	CLO1	Analyze the given problem to propose a computing based solution.	PLO3:Problem Analysis	Cognitive	4	
			CLO2	Design and develop computing solutions to	PLO4:Design and Development of Solutions	Cognitive	5	

				the complec computing problems.				
			CLO3	Demonstrate the ability to use modern tool to solve the given problem.	PLO5:Modern Tool Usage	Cognitive	3	
			CLO4	Demonstrate the ability to work affectively as an individual and a team member.	PLO6:Individual and Team Work	Cognitive	6	
			CLO5	Understand the significance of broader aspect of innovation and development	PLO10:Life Long Learning	Cognitive	6	
			CLO6	Demonstrate effective skills in verbal and written communication during presentations, discussions and reports.	PLO7:Communication	Affective	3	

BS (IT) CLOs with Cognitive Levels

S No.	Course Code	Course Title	CLO	Description of CLO	Mapped PLO	Domain	Skill Level	Comments by BUKC
1	GSC 110	Applied Calculus and Analytical Geometry	CLO1	Describe real value functions of one and more variables	PLO1:Academic Education	Cognitive	1	
			CLO2	Apply the concepts of limits and continuity to solve problems in differential calculus	PLO3:Problem Analysis	Cognitive	3	merge c2 and c3
			CLO3	Solve applied problems by applying concepts of Integration	PLO3:Problem Analysis	Cognitive	3	

2	CSC 114	Introduction to Information & Communication Technology	CLO 1	Describe the components of a computer system	PLO1:Academic Education	Cognitive	1	
			CLO 2	Understand the fundamentals of operating systems, databases, and number systems	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO 3	Explain Networking and Internet Technologies	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	bt level change c2 to c3
3	CSL 114	Introduction to Information & Communication Technology Lab	CLO 1	Observe the operations of various components of computing system	PLO1:Academic Education	Psychomotor	1	chnage wording of clo1
			CLO 2	Practice the basic computer application software like MS Word, MS Excel, MS Power Point, MS Access etc.	PLO5:Modern Tool Usage	Psychomotor	3	
			CLO 3	Demonstrate the use of communication and networking	PLO6:Individual and Team Work	Psychomotor	4	hange plo 6 to plo4
4	ENG 105	Functional English	CLO1	Demonstrate English listening skills to function successfully in target language listening situation.	PLO7:Communication	Affective	1	
			CLO2	Exhibit English reading skills to comprehend various aspects of the nature of the reading material.	PLO7:Communication	Affective	1	
			CLO3	Practice English speaking skills to express effectively through speech.	PLO7:Communication	Affective	2	

			CLO4	Demonstrate formal and informal English writing skills to express ideas and convey message to target readers.	PLO7:Communication	Cognitive	3	
5	CSC 113	Computer Programming	CLO1	Demonstrate the understanding of the basic concepts of programming	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	change plo2 to 1 of clo1
			CLO2	Exhibit logic building ability using basic programming concepts	PLO3:Problem Analysis	Cognitive	2	change btl to c4 of clo2, change plo3 to plo2 of clo2,analyze instead of exhibit
			CLO3	Apply programming concepts to model requirements and solve simple computing problems using a high level programming language	PLO4:Design and Development of Solutions	Cognitive	3	change plo4 to plo3 of clo3
6	CSL 113	Computer Programming Lab	CLO1	Demonstrate the understanding of programing language syntax and its usage	PLO2:Knowledge for Solving Computing Problems	Psychomotor	2	
			CLO2	Apply basic programming structures for logic construction	PLO3:Problem Analysis	Psychomotor	3	
			CLO3	Translate the devised solutions into computer programs and test the implementation	PLO5:Modern Tool Usage	Psychomotor	3	implement instead of translate.
7	GSC 114	Applied Physics	CLO1	Comprehend the working knowledge of fundamental laws of physics.	PLO1:Academic Education	Cognitive	2	rephrase clo 1 & clo2

			CLO2	Apply the knowledge of fundamental laws to solve various real world problems	PLO1:Academic Education	Cognitive	3	change plo1 to plo2 of clo2
			CLO3	Analyze different physical problems using the knowledge gained from different areas like electromagnetism, optics etc.	PLO3:Problem Analysis	Cognitive	4	
8	GSL 114	Applied Physics Lab	CLO1	Develop the ability to record readings using different measurements tools.	PLO5:Modern Tool Usage	Psychomotor	3	
			CLO2	Demonstrate an understanding of basic laws of Physics through relevant experimentation.	PLO6:Individual and Team Work	Psychomotor	4	
			CLO3	Show knowledge of constructing an electronic circuit for a given set of constraints.	PLO3:Problem Analysis	Psychomotor	5	
9	HSS 120	Communication Skills	CLO1	Participate actively in group discussions by exercising attentive listening and constructive debate.	PLO6:Individual and Team Work	Affective	2	
			CLO2	Initiate a conversation and communicate effectively by employing intermediate to advanced level English vocabulary.	PLO7:Communication	Affective	3	
			CLO3	Express or present ideas independently in	PLO7:Communication	Affective	3	

				front of an audience and effectively respond to queries.				
			CLO4	Learn strategies to manage apprehension before public speaking; and to implement vocal and physical behaviors to support communication;	PLO10:Life Long Learning	Cognitive	3	
10	CSC 210	Object Oriented Programming	CLO1	Develop an understanding of the underlying concepts of object oriented paradigm	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply object oriented concepts in solving computing problems	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Design and implement object oriented solutions for small real world problems including single/multiple objects	PLO4:Design and Development of Solutions	Cognitive	4	
			CLO4	Evaluate the workflow of an object oriented solution including error handling	PLO4:Design and Development of Solutions	Cognitive	5	
11	CSL 210	Object Oriented Programming Lab	CLO1	Demonstrate an understanding of object oriented design concepts and their mapping to object oriented programming	PLO4:Design and Development of Solutions	Psychomotor	3	
			CLO2	Implement and debug object oriented solutions for problems	PLO5:Modern Tool Usage	Psychomotor	4	

				involving multiple classes				
			CLO3	Demonstrate effective communication and teamwork	PLO6:Individual and Team Work	Affective	2	
12	GSC 221	Discrete Mathematics	CLO1	Demonstrate an understanding of the key concepts of Discrete Structures	PLO1:Academic Education	Cognitive	2	
			CLO2	Relate various discrete structures with different areas of Computer Science	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Apply formal logic proofs and/or informal, but rigorous, logical reasoning to real world problems.	PLO3:Problem Analysis	Cognitive	3	
			CLO4	Develop pseudocodes of algorithms for standard computing problems	PLO4:Design and Development of Solutions	Cognitive	3	
13	CEN 122	Digital Design	CLO1	Understanding of the Boolean Algebra, Boolean Functions, Combinational and Sequential Logic and PLDs.	PLO1:Academic Education	Cognitive	2	
			CLO2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	change clo2 to clo3 of clo3 and change
			CLO3	Understand the relationship between abstract logic characterizations and practical	PLO3:Problem Analysis	Cognitive	2	rephrase clo3, plo3 to plo4

				electrical implementations.				
14	CEN 122	Digital Design Lab	CLO1	Understand the tools and techniques for the design of digital electronic circuits	PLO1:Academic Education	Cognitive	2	
			CLO2	Demonstrate the skills to design and analyze both combinational and sequential circuits using a variety of techniques	PLO2:Knowledge for Solving Computing Problems	Psychomotor	3	
			CLO3	Apply the acquired knowledge to simulate and implement small-scale digital circuits	PLO3:Problem Analysis	Psychomotor	4	change p4 to p5 of clo3
15	CSC 221	Data Structure & Algorithms	CLO1	Explain and compare different data structures and their applications	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply appropriate data structures according to the given scenarios and application domain	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Analyze time complexity of different algorithms	PLO2:Knowledge for Solving Computing Problems	Cognitive	4	CHANGE plo2 to plo3 of clo3
			CLO4	Design efficient algorithm(s) to solve real world problems	PLO4:Design and Development of Solutions	Cognitive	6	eliminate C4
16	CSL 221	Data Structures and Algorithms Lab	CLO1	Implement different linear and non linear data structures	PLO3:Problem Analysis	Psychomotor	3	
			CLO2	Construct programs for	PLO4:Design and	Psychomotor	4	

				problems and application domain by using appropriate data structures.	Development of Solutions			
			CLO3	Demonstrate effective teamwork in solving problems	PLO6:Individual and Team Work	Affective	2	
17	CSC 307	Professional Practices	CLO1	Identify the content of religious, national, or international law dealing with professional ethics	PLO8:Computing Professionalism and Society	Affective	2	
			CLO2	Apply the knowledge of ethics in their personal and professional life	PLO9:Ethics	Affective	3	
			CLO3	Gain the ability to enhance key factors of interpersonal relations, to follow and implement the acquired knowledge of ethical skills in given situations by controlling his/her temperament.	PLO10:Life Long Learning	Affective	4	
18	GSC 121	Linear Algebra	CLO1	Interpret the fundamental concepts of linear algebra, vector equations and linear transformations.	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply the basic knowledge of vector spaces, eigen value and eigen vectors to solve the critical problems of Linear Algebra	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	

			CLO3	Solve systems of linear equations appearing in different engineering applications	PLO3:Problem Analysis	Cognitive	3	
19	GSC 122	Probability and Statistics	CLO1	Explain and express the basic understanding of probability and statistics.	PLO1:Academic Education	Cognitive	2	
			CLO2	Demonstrate an ability to use descriptive techniques to describe the statistical data.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Apply inferential statistical methods to solve problems.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO4	Analyze and investigate any given data distribution.	PLO3:Problem Analysis	Cognitive	4	
20	CEN 222	Data Communications and Networking	CLO1	Understand basic principles and functionalities of Data Communication and Networks.	PLO1:Academic Education	Cognitive	2	
			CLO2	Explain the services and functions provided by each layer in the Internet protocol stack.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Identify various internetworking devices and protocols, and their functions in a network.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
21	CEL 222	Data Communications and	CLO1	Make different cable types.	PLO1:Academic Education	Psychomotor	2	demonstrate instead of make in

		Networking Lab						clo1,change plo1 to plo3 of clo1
			CLO2	Apply and simulate different routing protocols like RIP, OSPF, NAT and ACL.	PLO5:Modern Tool Usage	Psychomotor	3	
			CLO3	Build Computer Network (s) on various topologies.	PLO6:Individual and Team Work	Psychomotor	3	
22	CSC 320	Operating Systems	CLO1	Understand the characteristics of different structures of the Operating Systems and identify the core functions of the Operating Systems.	PLO1:Academic Education	Cognitive	2	
			CLO2	Apply the concepts of memory management, I/O management CPU management and processor management etc.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Analyze the algorithms of the core functions of Operating Systems and explain the major performance issues with respect to the core functions.	PLO3:Problem Analysis	Cognitive	4	
23	CSL 320	Operating Systems Lab	CLO1	Implement OS concepts like those of shell scripting, processes, file manipulation and inter-processes communication	PLO3:Problem Analysis	Psychomotor	2	

			CLO2	Demonstrate the knowledge in applying system software and tools available in modern operating systems	PLO5:Modern Tool Usage	Psychomotor	4	
24	CSC 407	Information Security	CLO1	Explain key concepts of information security such as design principles, cryptography, risk management, and ethics.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO2	Apply various security and risk management tools for achieving information security and privacy.	PLO5:Modern Tool Usage	Cognitive	3	
			CLO3	Identify appropriate techniques to tackle and solve problems in the discipline of information security.	PLO3:Problem Analysis	Cognitive	4	
			CLO4	Create solutions to real life scenarios using different security related tools.	PLO4:Design and Development of Solutions	Cognitive	6	eliminate clo4
25	CSC 220	Database Management Systems	CLO1	Explain the fundamental concepts of databases	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO2	Apply different database models to design conceptual, logical, and physical databases	PLO4:Design and Development of Solutions	Cognitive	3	
			CLO3	Apply queries to extract	PLO5:Modern Tool Usage	Cognitive	3	eliminate clo3

				information from databases				
			CLO4	Analyze user requirements to design a database for the given scenarios	PLO4:Design and Development of Solutions	Cognitive	4	
26	CSL 220	Database Management Systems Lab	CLO1	Practice writing SQL commands to perform different tasks	PLO4:Design and Development of Solutions	Psychomotor	3	clo1 should be rephrase
			CLO2	Make ER diagrams as to analyze and interpret data design of database	PLO3:Problem Analysis	Psychomotor	4	remove make ER diagrams as from clo2
			CLO3	Make a simple database system and demonstrate competence with the fundamental tasks involved with modeling, designing, and implementing a DBMS	PLO5:Modern Tool Usage	Psychomotor	4	design instead of make in clo3
27	SEN 220	Software Engineering	CLO1	Describe various software engineering processes and activities	PLO1:Academic Education	Cognitive	1	
			CLO2	Apply knowledge of software engineering appropriate to the discipline, particularly in the modeling, design, testing and deployment of software systems.	PLO4:Design and Development of Solutions	Cognitive	3	clo2 map to plo2 instead of plo4
			CLO3	Analyze and solve small scale Software Engineering problems	PLO3:Problem Analysis	Cognitive	4	

28	ITC 311	IT Project Management	CLO1	Understand the key elements of the IT project management framework and explain the principles of project life cycle.	PLO1:Academic Education	Cognitive	2	
			CLO2	Work in teams to plan various project activities in a scientific way to monitor performance..	PLO6:Individual and Team Work	Cognitive	3	
			CLO3	Implement and manage project schedule using appropriate project management tools.	PLO5:Modern Tool Usage	Cognitive	3	
			CLO4	Choose appropriate project management techniques for IT projects.	PLO2:Knowledge for Solving Computing Problems	Cognitive	5	eliminate clo4,recheck whether advance tool used in this course or not
29	SEN 458	Software Requirement Engineering	CLO1	Understand and explain the significance of systematic requirements engineering processes and techniques.	PLO1:Academic Education	Cognitive	2	change plo 1 to plo2 of clo1
			CLO2	Employ standard requirements engineering techniques for eliciting, analyzing, validating, and managing software requirements.	PLO3:Problem Analysis	Cognitive	3	change plo3 to plo2 of clo2
			CLO3	Identify and analyze software requirements for a medium-scaled Software project.	PLO3:Problem Analysis	Cognitive	4	

30	ITC 226	Web Systems and Technologies	CLO1	Discuss how web standards impact software development.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO2	Describe the constraints that the web puts on developers.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Design and Implement a simple web application.	PLO4:Design and Development of Solutions	Cognitive	4	
			CLO4	Review an existing web application against a current web standard.	PLO6:Individual and Team Work	Cognitive	5	eliminate clo4
31	ITL 226	Web Systems and Technologies Lab	CLO1	Understand the design and architecture pertaining to web systems.	PLO1:Academic Education	Cognitive	2	
			CLO2	Demonstrate proficiency is using different web development tools.	PLO5:Modern Tool Usage	Psychomotor	4	
			CLO3	Design and implement integrated web-based solutions following standards and best practices.	PLO4:Design and Development of Solutions	Psychomotor	4	
32	ITC 312	System and Network Administration	CLO1	Demonstrate an understanding of the basic principles and functionalities of system and network administration.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO2	Design the network architecture for a given scenario.	PLO4:Design and Development of Solutions	Cognitive	3	

			CLO3	Analyze the requirements and design and configure a client-server network and the network services for a given scenario.	PLO3:Problem Analysis	Cognitive	4	
33	ITL 312	System and Network Administration Lab	CLO1	Design and configure peer-to-peer and client-server networks.	PLO6:Individual and Team Work	Psychomotor	4	
			CLO2	Configure IP Addressing schemes, DNS, DHCP and FTP etc.	PLO5:Modern Tool Usage	Psychomotor	4	
			CLO3	Manage network services and network monitoring tools.	PLO5:Modern Tool Usage	Psychomotor	4	
34	ITC 321	Enterprise Systems	CLO1	Demonstrate an understanding of enterprise systems.	PLO1:Academic Education	Cognitive	2	remove CLO 1
			CLO2	Elaborate the scope of common enterprise system modules such as SCM, CRM, HRM in local and global contexts	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Implement a strategy for selected business process(es) in enterprise systems.	PLO4:Design and Development of Solutions	Cognitive	3	
			CLO4	Analyze the challenges associated with the implementation of enterprise systems.	PLO3:Problem Analysis	Cognitive	4	
35	ITC 324	IT Infrastructure	CLO1	Understand the key elements of an IT Infrastructure solution.	PLO1:Academic Education	Cognitive	2	CHANGE PLO1 TO PLO2 OF CLO1

			CLO2	Analyze the requirements and identify the core IT infrastructure components for a given scenario.	PLO3:Problem Analysis	Cognitive	4	
			CLO3	Appraise the current trends in IT Infrastructure and Infrastructure Management.	PLO2:Knowledge for Solving Computing Problems	Cognitive	5	REMOVE CLO3
			CLO4	Design an IT infrastructure solution for a small organization.	PLO4:Design and Development of Solutions	Cognitive	6	
36	HSS 320	Technical Writing and Presentation Skills	CLO1	Demonstrate an appropriate communication style to different types of audiences in an ethically responsible manner	PLO9:Ethics	Affective	2	
			CLO2	Demonstrate competence in producing technical documents.	PLO7:Communication	Affective	3	
			CLO3	Work on a standard word processing software along with a referencing tool for writing technical reports.	PLO5:Modern Tool Usage	Psychomotor	4	
			CLO4	Present topics using modern presentation skills and demonstrate a thorough understanding of verbal and non-verbal communication	PLO7:Communication	Affective	3	
37	ITC 411	Cyber Security	CLO1	Identify various computer system threats.	PLO1:Academic Education	Cognitive	2	REMOVE CLO1

			CLO2	Identify Malware attacks and understand the stages of attack and payloads	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Implement various cryptographic techniques and simulate attack scenarios	PLO5:Modern Tool Usage	Cognitive	3	
			CLO4	Generate and analyze reports based on digital forensic tools for security systems and platforms	PLO5:Modern Tool Usage	Cognitive	4	
38	ITC 424	Database Administration and Management	CLO1	Explain the advanced data models such as object-relational and object-oriented models.	PLO1:Academic Education	Cognitive	2	
			CLO2	Implement the user roles and associated permissions as per the computing practices.	PLO2:Knowledge for Solving Computing Problems	Cognitive	3	
			CLO3	Analyze file organization techniques to optimize memory allocation of databases.	PLO3:Problem Analysis	Cognitive	4	
			CLO4	Identify and assess the ethical considerations to ensure the integrity and security of databases.	PLO9:Ethics	Cognitive	5	
39	ITL 424	Database Administration and Management Lab	CLO1	Implement query optimization and file organization techniques.	PLO5:Modern Tool Usage	Psychomotor	4	
			CLO2	Define and apply user roles and permissions.	PLO8:Computing Profession	Psychomotor	4	

					alism and Society			
			CLO3	Manage large databases within an enterprise.	PLO10:Life Long Learning	Psychomotor	5	
40	PAK 101	Pakistan Studies	CLO1	Demonstrate the understanding of political and constitutional system of Pakistan	PLO8:Computing Professionalism and Society	Cognitive	2	
			CLO2	Understand the social, moral, and cultural values system of Pakistan.	PLO9:Ethics	Cognitive	2	
			CLO3	Analyze the contemporary problems faced by Pakistan (social, human resource, economic development, food safety / water resources)	PLO8:Computing Professionalism and Society	Cognitive	4	
			CLO4	Develop an understanding and appreciation for patriotism and loyalty towards national interest.	PLO10:Life Long Learning	Cognitive	4	
41	ITC 422	Virtual Systems and Services	CLO1	Demonstrate an understanding of the key concepts of virtual machines and virtualization in computing systems.	PLO1:Academic Education	Cognitive	2	
			CLO2	Understand virtual networks and storage.	PLO2:Knowledge for Solving Computing Problems	Cognitive	2	
			CLO3	Deploy and manage virtual machines.	PLO5:Modern Tool Usage	Cognitive	3	Eliminate clo3
42	ITL 422	Virtual Systems and Services Lab	CLO1	Install and configure virtualization	PLO5:Modern Tool Usage	Psychomotor	4	

				technology such as VMware.				
			CLO2	Configure and manage virtual network and storage.	PLO5:Modern Tool Usage	Psychomotor	4	
			CLO3	Implement private cloud platform using virtualization and use virtual machines of public cloud platform.	PLO10:Life Long Learning	Psychomotor	5	
43	PAK 101	Islamic Studies	CLO1	Demonstrate the understanding of fundamental human rights and relation with non-Muslims through discussion on related issues	PLO9:Ethics	Cognitive	2	
			CLO2	Demonstrate knowledge of Islamic civilization and moral values.	PLO10:Life Long Learning	Cognitive	2	
44		Final Year Project	CLO1	Analyze the given problem to propose a computing based solution.	PLO3:Problem Analysis	Cognitive	4	
			CLO2	Design and develop computing solutions to the complex computing problems.	PLO4:Design and Development of Solutions	Cognitive	5	
			CLO3	Demonstrate the ability to use modern tool to solve the given problem.	PLO5:Modern Tool Usage	Cognitive	3	
			CLO4	Demonstrate the ability to work affectively as an individual and a team member.	PLO6:Individual and Team Work	Cognitive	6	
			CLO5	Understand the significance of broader aspect of innovation and development	PLO10:Life Long Learning	Cognitive	6	

			CLO6	Demonstrate effective skills in verbal and written communication during presentations, discussions and reports.	PLO7:Communication	Affective	3	

Appendage 2509

Existing PEOs	Proposed PEOs
• **PEO 1:** Attain an ability to identify and solve challenging problems in their professions by applying theory, principles and related tools learnt during degree program. • **PEO 2:** Demonstrate effective communication as an individual or team player with strong managerial and entrepreneurial skills. • **PEO 3:** Maintain highest ethical and professional standards in pursuing their careers. • **PEO 4:** Engage in life-long learning to continually polish their professional	• **PEO 1:** Demonstrate excellence in the profession through in-depth knowledge and skills in the field of Computer Engineering. • **PEO 2:** Demonstrate effective management and communication skills being an individual or a team member. • **PEO 3:** Show professional integrity and commitment to social and ethical responsibilities. • **PEO 4:** Engage in continuous professional development for their personal growth and the betterment of society.

capabilities for their personal growth and the betterment of society	

Mapping of PLOs to PEOs

	Graduate Attributes As per Pakistan Engineering Council	PEO 1	PEO 2	PEO 3	PEO 4
PLO 1	Engineering Knowledge	✓			
PLO 2	Problem Analysis	✓			
PLO 3	Design/Development of Solutions	✓			
PLO 4	Investigation	✓			
PLO 5	Modern Tool Usage	✓			
PLO 6	The Engineer and Society			✓	✓
PLO 7	Environment and Sustainability			✓	
PLO 8	Ethics			✓	
PLO 9	Individual and Team Work		✓		
PLO 10	Communication		✓		
PLO 11	Project Management		✓		
PLO 12	Lifelong Learning				✓

Appendage 2510

KPI Mapping

Computer Engineering (BUIC & BUKC)
For PEOs:

Program Educational Objectives (PEOs)		**Key Performance Indicator (KPI's)**	**Assessment Tools**	**Threshold** **(Optional)**
PEO 1	Attain an ability to identify and solve challenging problems in their professions by applying theory, principles and modern tools learnt during degree program.	**A** & **B**	**A.** Alumni Feedback **B.** Employer Feedback	> 50% (A) > 50% (B)
PEO 2	Demonstrate effective communication as an individual or team player with strong managerial and entrepreneurial skills.	**A**&**B**&**C**&**D**	**A.** Alumni Feedback **B.** Alumni Employment Status **C.** Alumni Designation Field **D.** Employer Feedback	> 50% (A) > 5% (B) > 10% (C) > 50% (D)
PEO 3	Maintain highest ethical and professional standards in pursuing their careers.	**A** & **B**	**A.** Alumni Feedback **B.** Employer Feedback	> 30% (A) > 70% (B)

PEO 4	Engage in life-long learning to continually polish their professional capabilities for their personal growth and the betterment of society.	**A**&**B**&**C**&**D**	**A.** Higher Education field in Alumni Feedback **B.** Membership of professional engineering bodies in Alumni Feedback **C.** Working for the betterment of Society/Welfare in Alumni Feedback **D.** Employer Feedback	> 10% (A) > 80% (B) > 10% (C) > 60% (D)

For PLOs:

Program Learning Outcomes (PLOs)	Assessment Tools	Key Performance Indicator (KPI's)	Assessment Time
Program PLO assessment	A. Exit Survey (Indirect Assessment) CSP Survey (Indirect Assessment) Internship Feedback (Indirect Assessment)	**A & B & C** **A. > 60%** **B. > 60%** **C. > 60%**	**End of degree**
Student PLO assessment	(Direct Assessment)	**> 60%**	**At the end of 6th, 7th, and 8th Semesters**

For CLOs:

Course Learning Outcome (CLOs)	Assessment Tools	Key Performance Indicator (KPI's)	Assessment Time

Course (and or lab) wise CLO assessment	Course (and or lab) Assessment tools: A. Quizzes B. Assignments C. Projects/CEPs (Optional) D. Exams	**> 50%**	**End of each semester**

Appendage 2511

Internship Survey Form – OBE

Department of _______ Engineering – BU__

(To be filled by the Manager/In charge/Supervisor/Team Lead)

Form No. PEC-L2-02A

Introduction

a. Evaluator Profile

Name:______________________________ Email:____________________________

Contact:_____________________________ Designation: ________________________

Organization: _________________________

b. Internee Profile:

Student Name:______________________________ Enrollment No:_________________________

Duration of Internship :___________________________ Batch: _______________________________

c. Internee Performance evaluation:

Please respond to the following by encircling the most appropriate choice.

5: Very strong **4:** Strong **3:** Moderate **2:** Weak **1:** very Weak **0:** Not applicable

Sno.	Statements	PLOs	5	4	3	2	1	0
1	Demonstrate and show the ability to acquire the fundamental engineering knowledge	PLO- 01						
2	Demonstrate the ability to analyze engineering problem(s)	PLO- 02						
3	Demonstrate the ability to design a system component or process	PLO- 03						
4	Demonstrate the ability to investigate appropriate source of data to the assigned task	PLO- 04						
5	Demonstrate the ability to use modern software/hardware tools during internship	PLO- 05						
6	Demonstrate the sensitivity towards societal issues and provision of relevant solutions through engineering knowledge	PLO- 06						
7	Awareness of applying engineering knowledge for sustainable development	PLO- 07						
8	Punctuality and attitude towards assigned task(s) at internship	PLO- 08						
9	Self-confidence to accomplish task(s) independently and to coordinate and collaborate with the team to perform the task(s)	PLO- 09						

10	Demonstrate the ability to communicate effectively (both verbal and non-verbal)	PLO- 10						
11	Demonstrate the ability to manage assigned task(s) within given constraints	PLO- 11						
12	Demonstrate the initiative and drive for learning new things	PLO- 12						

PLO1: Engineering knowledge	**PLO5: Modern Tool usage**	**PLO9:Indiv.& Team work**
PLO2: Problem Analysis	**PLO6: The Engineer and society**	**PLO10: Communication**
PLO3: Design/development of solution	**PLO7: Environment &sustainability**	**PLO11: Project Management**
PLO4: Investigation	**PLO8: Ethics**	**PLO12: Lifelong learning**

d. General remarks:

____

____

____

Signature of Manager/In charge/Supervisor/Team Lead/Career Service Coordinator and Date

Appendage 2512

Course Title: **Blockchain Application Development**
Prerequisite: Computer Programming (CSC 113)
Credit Hours: 2+1

This course covers topics that are relevant to the emerging area of Blockchain and its decentralized application developments. The course is mainly divided into two parts; where the first part will cover the fundamentals concepts of Blockchain technology, while the second part will cover the concepts related to the development of Blockchain based applications. In this course, you will also learn how to gather requirements, design, code, deploy and test applications while using blockchain technology. The topics that would be discussed include:

1) <u>Blockchain Fundamentals</u>

- Introduction to Blockchain technology.
- Blockchain data structure.
- Public Key Infrastructure and blockchain.
- Distributed Ledgers.

2) <u>Blockchain Application Development</u>

- **DApp Development:** DApp Development is the process of building decentralized applications with backend code running on a decentralized peer-to-peer network.
- **Smart Contracts Development:** A smart contract is a self-executing contract with the terms of the agreement between buyer and seller being directly written into lines of code. The code and the agreements contained therein exist across a distributed, decentralized blockchain network.

- **Solidity:** Solidity is an object-oriented programming language for writing smart contracts, where it is used for implementing smart contracts on various blockchain platforms, most notably Ethereum.
- **Web3:** Web3 is an idea for a version of the Internet that is decentralized and based on public blockchains.
- **React (web3-react):** web3-react is a simple, powerful framework for building modern Ethereum dApps using React.
- **Mocha:** Mocha is a feature-rich JavaScript test framework running on Node .js and in the browser, making asynchronous testing simple and fun. Mocha tests run serially, allowing for flexible and accurate reporting, while mapping uncaught exceptions to the correct test cases. Hosted on GitHub.
- **Ethereum:** Ethereum is a blockchain platform with its own cryptocurrency, called Ether (ETH) or Ethereum, and its own programming language, called Solidity. As a blockchain network, Ethereum is a decentralized public ledger for verifying and recording transactions.
- **Blockchain Programming for Front-end**

Recommended Books:

1. B. Ramamurthy, “Blockchain in Action”, Manning Publishing, 2020.
2. Roger Wattenhofer, “Blockchain Science: Distributed Ledger Technology”, Independently published, 2019.
3. Imran Bashir, “Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained”, Packt Publishing, 2018.

BAHRIA UNIVERSITY KARACHI CAMPUS
DEPARTMENT OF SOFTWARE ENGINEERING

Course Title: Blockchain Application Development
Course Code: SEN-

S#	Experiment Titles
1	Introduction to Blockchain Development Framework
2	Blockchain Data structure
3	DApps on a Public Blockchain
4	Smart Contract with Different Blockchain Networks
5	Solidity Programming Basics
6	Arrays and Maps using Solidity Programming
7	Smart Contract using Solidity Programming
8	Managing Smart contract using Web3.js and node js
9	Using Web3.js to Transfer Ether from One Account to Another
10	Using Web3.js to Interact with Smart Contracts
11	Building Ethereum DApp with React Web3
12	Installing and setting up Mocha, a JavaScript unit testing framework
13	Introduction to Enterprise Blockchain, Hyperledger and Hyperledger Fabric
14	Interacting with Ethereum wallet

BAHRIA UNIVERSITY KARACHI CAMPUS
DEPARTMENT OF SOFTWARE ENGINEERING

Course Title: SOFTWARE QUALITY ENGINEERING
Course Code: SEL-321

S#	Experiment Titles
1	Software Quality tools and framework
2	Manual Adhoc test cases design and execution
3	Control flow graph, cyclomatic complexity, independent paths
4	Selenium Tool
5	Test plan document
6	Unit Testing
7	Smoke Testing
8	Sanity Testing
9	Regression Testing
10	Integration testing & API testing
11	System Testing
12	White Box & Black Box Testing (UI Testing)
13	Acceptance Testing & Alpha Testing
14	Beta Testing & Production Testing

Identified Courses for CQI on CLOs

Table 1 presents a summary of the identified courses over which CQI process at the CLO level applies. In addition, the table also presents the main feedback from instructors on the performance of those CLOs falling below the 60% threshold for a given cohort (i.e. both sections A&B) or for a single section (in case the course was offered to only one section).

Table 1: Courses for CQI on CLOs along with Instructor's Feedback.

Feedback based on CLOs Analysis done by QA Committee (Fall 2019, Spring 2020, Fall 2020 & Spring 2021)				
S. No.	**Course & Semester**	**Course Instructor**	**CLOs Considered Under Review**	**Instructor's Feedback**
1.	Data Structures & Algorithms Lab ***(Fall 2019)***	Engr. Bushra Fazal & Engr. Saniya Shaikh	CLO#4: Adapt the skills to perform the task related to data structures concepts and algorithms.	The major reason behind this poor performance is due to mapping of OEL-I and OEL-II to CLO#4, for which the students were not properly trained. Weightage of CLO#4 was 30% which is a high rate and should be reduced.
2.	Visual Programming Lab ***(Fall 2019)***	Engr. Muhammad Faisal & Engr. Ramsha Mashood	CLO#4: Adapt the skills to perform the task related to visual programming concepts and techniques	Student need to understand real world scenarios and try to implement them without any guide and by using their own technique for development and designing as taught in lab.
3.	Artificial Intelligence ***(Fall 2020)***	Dr. Amina Jameel	CLO#2: Explain the concepts and working mechanism related to informed/uninformed search algorithms, including local search strategies, adversarial search strategies and learning algorithms.	Students are week in elaborating concepts in their own wordings.
4.	Artificial Intelligence ***(Fall 2020)***	Dr. Amina Jameel	CLO#3: Solve a variety of numerical problems related to different algorithms in AI.	Students are weak in analysis.
5.	Applied Calculus and Analytical Geometry ***(Fall 2020)***	Engr. Faiz ul Haq Zeya	CLO#1: Define the basics of concept of derivatives / integration and its rules.	-
6.	Software Quality Engineering ***(Spring 2021)***	Engr. Majid Kaleem & Engr. Misbha Perveen	CLO#4: Analyze various software testing techniques and tools suitable for a given scenario.	One section has performed well while the other did not. Hence, the issue with the week section may be addressed.

CQI in Data Structure & Algorithms Lab / Visual Programming Lab

In Data Structure & Algorithms Lab ***(Fall 2019)***, details of class-wise and cohort-wise CLOs attainments are as presented in Table 2. In CLO#4, the QA team has observed that cohort-wise CLO attainment along with class-wise

CLO attainment is falling below the set threshold of 60%. Hence, the observation along with recommendations were reported to the CQI team.

Table 2: Data structure and algorithm Lab CLOs attainment.

Group Type	CLO1	CLO2	CLO3	CLO4	CLO5
BSE-3A	94%	94%	97%	52%	94%
BSE-3B	93%	97%	97%	47%	97%
Cohort	93.5%	95.5%	97%	49.5%	95.5%

In Visual Programming Lab ***(Fall 2019)***, details of class-wise *(i.e. only offered for one section BSE-5B)* CLOs attainments are as given in Table 3. In CLO#4, the QA team has observed that class-wise CLO attainment is falling below the set threshold of 60%. Hence, the observation along with recommendations were reported to the CQI team.

Table 3: Visual programming Lab CLOs attainment.

Group Type	CLO1	CLO2	CLO3	CLO4	CLO5
BSE-5B	100%	100%	100%	58%	100%

The QA team has observed that in both above described labs, the concerned cohorts have failed to attained CLO#4 which are related to Open-Ended Lab (OEL). It was observed that total of two OELs are executed in each semester, with dedicated and high weightage points of 15 marks being assigned to each OEL, hence a total of 30 marks is assigned to the two OELs. The adopted performance assessment instrument of OELs was through two dedicated lab sessions in which OELs were provided and evaluated, and for that a dedicated CLO was devised (i.e. CLO#4). Since OEL is a challenging task by its nature, hence it was noticed that students failed to gain good marks in it and hence against its mapped CLO#4.

The QA committee has also realized that such issues may arise in other labs subjects as well that may lead towards repeated failure of cohort in subsequent courses. Hence, the QA committee has directed the CQI committee to look into this matter from a general perspective rather than considering these two courses only. As a result, the CQI committee has executed a corrective action in which the Labs marking scheme was revised. In this revision, OELs are assessed as any normal lab rather than giving it as a special task equivalent to an exam with high weightage. In addition, its mapping to a dedicated CLO has been removed resulting into the revision of labs' CLOs. Old and new Labs marking schemes are given in Table 4 and Table 5, respectively. Accordingly, the marks distribution in Lab Rubrics have been revised as well. Effectiveness of this new marking scheme was applicable from Fall 2020 semester.

Table 4: Old Labs Marking Scheme.

Assessment Tool	Marks
Lab Assessment	15 marks
Lab Journal	10 marks
Lab Journal Viva	5 marks

Assignments x 2	10 marks
Open Ended Lab-I	15 marks
Open Ended Lab-II	15 marks
Project Demonstration	20 marks
Project Viva / Report	10 marks
Total	**100 marks**

Table 5: Revised Labs Marking Scheme (Adopted for Fall 2020 & Spring 2021).

Assessment Tool	Marks
Lab Assessment (includes OEL)	30 marks
Assignments x 2	10 marks
Lab Journal	20 marks
Lab Journal Viva / Exam	10 marks
Project Demonstration	20 marks
Project Viva / Report	10 marks
Total	**100 marks**

CQI in Artificial Intelligence

In Artificial Intelligence ***(Fall 2020)***, details of class-wise and cohort-wise CLOs attainments are as presented in Table 9. In CLO#2 and CLO#3, the QA team has observed that cohort-wise CLO attainment is falling below the set threshold of 60%. Hence, the observation along with recommendations were reported to the CQI team.

Table 9: Artificial Intelligence Theory CLOs attainment.

Group Type	CLO1	CLO2	CLO3	CLO4
BSE-5A	**94%**	**36%**	**45%**	**91%**
BSE-5B	**94%**	**45%**	**52%**	**81%**
Cohort	**94%**	**40.5%**	**48.5%**	**86%**

The concerned course instructor was also informed about this observation and her feedback was taken as well. After further discussion and analysis, it was concluded that both CLO#2 and CLO#3 are suitable in principal and does not need any revision. However, performance of the cohort was a concern that needed to be addressed and improved. For that, it was recommended by the QA committee to offer a course in the same domain of Artificial Intelligence to both sections BSE-5A&B to further improve their cognitive skills related to both explaining concepts and problem solving. For that, the students of both sections were encouraged to take an elective course, namely Data Mining, in the upcoming Spring 2021 semester. Moreover, it was proposed to re-evaluate the performance of these two sections at the end of Spring 2021 for the course Data Mining to identify the progress made and the need for any further action.

CQI in Applied Calculus and Analytical Geometry

In Applied Calculus and Analytical Geometry ***(Fall 2020)***, details of class-wise and cohort-wise CLOs attainments are as presented in Table 10. In CLO#1, the QA team has observed that cohort-wise CLO attainment is falling below the set threshold of 60%. Hence, the observation along with recommendations were reported to the CQI team.

Table 10: Applied Calculus and Analytical Geometry Theory CLOs attainment.

Group Type	CLO1	CLO2	CLO3
BSE-1A	48%	69%	79%
BSE-1B	70%	81%	86%
Cohort	59%	75%	82.5%

After discussing the matter, it was concluded that CLO#1 does not need any major revision. However, changing the CLO's evaluation mechanism from "Definition" related questions to "Description" related questions may ease up the challenge on students and would also provide a better evaluation approach to the concerned faculty member. For that, a minor revision of the CLO was decided as shown below.

Old CLO#1 for Applied Calculus and Analytical Geometry

CLO 1: Define the basics of concept of derivatives / integration and its rules.

Revised CLO#1 for Applied Calculus and Analytical Geometry

CLO 1: Describe the basics concept of differentiation and integration and their rules.

CQI in Software Quality Engineering

In Software Quality Engineering ***(Spring 2021)***, details of class-wise and cohort-wise CLOs attainments are as presented in Table 11. In CLO#4, the QA team has observed that cohort-wise CLO attainment is falling below the set threshold of 60%. Hence, the observation along with recommendations were reported to the CQI team.

Table 11: Software Quality Engineering Theory CLOs attainment.

Group Type	CLO1	CLO2	CLO3	CLO4	CLO5
BSE-6A	100%	100%	94%	91%	100%
BSE-6B	73%	96%	85%	23%	96%
Cohort	86.5%	98%	89.5%	57%	98%

The concerned CLO#4 is related to analysis of requirements for scenario based problems. The QA committee considers such problems as essential elements for students' learning and an effective approach through which Problem Based Learning (PBL) can be attained. Hence, the committee concluded that concerned CLO#4 should not be revised and the same would be kept for the said course. However, in order to improve the overall cohort performance for the underlying CLO, the committee has advised to enhance the exposure of students to such problems through this course and in other relevant courses, while also providing suitable training to students on how to address such problems. Considering the course instructor's feedback, the committee has approved the elective course "Software Re-engineering" as a suitable course that should be offered in the upcoming semester to the same cohort in which similar problems can be addressed.

An exercise which included lectures on the underlying CLO followed by an evaluation process has been conducted on BSE-7B students by the course instructor of "Software Re-engineering". The assessment resulted into a score of 73% on average and a 100% attainment for the said exercise. Details of the exercise and evaluation process is as given below.

BAHRIA UNIVERSITY (KARACHI CAMPUS)
Software Quality Engineering (SEN-321)
CQI ACTIVITY
Based on: CLO-4

Class: **BSE-6B** Session Date: **24th Dec 21**

Session Conductor: **Engr. Majid Kaleem** Assessment Method: **Viva Voce**

In order to make up the deficiency exhibited by the students in the following CLO, a comprehensive and interactive session was conducted on the 1st December 2021 by the same subject teacher who taught them Software Quality Engineering in Spring 2021:

CLO #	CLO Statement	Bloom's Taxonomy	Associated PLO
CLO4	Analyze various software testing techniques and tools suitable for a given scenario.	C4	PLO2

Several real-life scenarios pertaining to BU LMS, CMS, OBE Portal, Daraz.com were presented as use cases. In addition, several other situations were also thoroughly discussed and the suitability of various testing techniques and tools were also explained.
In the following session, the effectiveness of the session was evaluated by conducting face-to-face viva on individual basis. Since each student is required to achieve at least 50% in order to pass a particular CLO. Therefore, each student was asked four questions (4 x 25% = 100%). And in order to achieve at least 50% marks one had to correctly answer at least two questions. Questions were asked randomly and the following table illustrates students' performance obtained through their responses:

Enrolment	Name	Viva Questions ×: Incorrect Answer ✓: Correct Answer				Total
		Q1	Q2	Q3	Q4	
02-131182-008	Muhammad Arbab Anjum	✓	✓	✓	✓	100%
02-131182-009	Gul Saba	×	×	✓	✓	50%
02-131182-010	Zubair Ahmed	✓	✓	×	✓	75%
02-131182-012	Shizrah Khalid	×	✓	✓	✓	75%
02-131182-014	Aqib Mehmood	✓	×	✓	✓	75%
02-131182-021	Muhammad Ammar Khan	✓	×	✓	✓	75%
02-131182-023	Mahnoor Gohar	✓	✓	✓	✓	100%
02-131182-026	Muhammad Arsalan	✓	×	✓	✓	75%
02-131182-027	Farhan Najam	×	✓	×	✓	50%
02-131182-030	Qaiser Abbas	✓	×	✓	×	50%
02-131182-031	Shahwar Afridi	✓	×	✓	✓	75%

02-131182-032	Laiba Afsar	✓	×	✓	×	50%
02-131182-035	Muhammad Moiz	×	✓	✓	×	50%
02-131182-039	Fehmaan Shahid Khan	✓	✓	✓	×	75%
02-131182-042	Kainat Ejaz Siddiqui	✓	✓	✓	✓	100%
02-131182-050	Asma Ahmad	✓	✓	✓	✓	100%
02-131182-053	Aamir Alihussain	✓	×	✓	✓	75%
02-131182-055	Syeda Bushra Naqvi	✓	✓	×	✓	75%
02-131182-058	Tehreem Amjad	✓	×	✓	×	50%
02-131182-060	Laraib Siddiqui	✓	✓	×	✓	75%
02-131182-062	Muhammad Faisal Qasim	✓	×	✓	✓	75%
02-131182-070	Syed Ali Abbas	×	✓	✓	×	50%
02-131182-074	Ali Hamza	✓	✓	✓	×	75%
02-131182-080	Muhammad Qasim Butt	✓	×	✓	✓	75%
02-131182-084	Madiha Binte Amir	✓	✓	✓	✓	100%
Overall CLO-04 Performance Assessment:						**73%**

Engr. Majid Kaleem

Session Conductor & Evaluator

Appendage 2515

PLO Assessment

Assessment of PLOs is done through two approaches, i.e. Direct Assessment and a combination of Direction & Indirect Assessments, as discussed below:

1. The Direct Assessment approach is used to evaluate performance of individual students, and to decide on whether to take a corrective action on the concerned student or not.
2. The combination of Direct & Indirect Assessments approach is used to evaluate performance of the complete cohort against each of the 12 PLOs in BSE program, and to decide on whether to take a corrective action on formulation of the PLO itself.

End of Spring 2020 Semester

CQI over Intake 2016

In the data provided in Appendix A.29 *(SAR)*, it can be seen that two students of Batch 2016 are lacking in attaining the 60% PLO threshold at end of their 8^{th} semester. This has been brought in to the notice of CQI Committee and several suggestions have been discussed for the identified individuals as per the defined CQI process.

Corrective Actions for students of Batch 2016 (End of Spring 2020).

Students Name	PLOs Attainment at end of 8th semester	Corrective Actions taken as per suggested by QA Committee
Muhammad Sajid Mehmood	PLO 7 = 0% PLO 11 = 0%	The student has frozen one semester of his studies (i.e. Spring 2018), yet to do his FYP and has also failed in several subjects. Also, the student has not taken any course that maps to PLO7 and PLO11, hence obtaining an attainment of zero on both. The QA committee came to the decision that for now, no additional action is necessary to be taken on the student other than that he needs to take/repeat the courses that are left to complete his degree plan, including FYP. This is to especially make sure that upcoming courses would map to PLO 7 and PLO 11. The above point was augmented with the fact that student is yet to study "Engineering Ethics" which maps to PLO 7, "Software Project Management" which maps to PLO 11, and FYP which maps to both PLOs. These courses are core courses to take in the degree plan. The above matter was discussed with the student for his knowledge. Currently, several courses are already taken by the student in the current Fall 2020 semester that maps to PLO 7 and PLO 11, for which the student will be evaluated for their attainment.
Muhammad Usama	PLO 6 = 50% PLO 7 = 50%	The student did not attempt the final exams of several courses in (Fall 2019 semester) due to personal reasons. In general, the QA committee observed that the student has a good achievements track in study. Due to his inability to appear in exams for the courses "Engineering Ethics" and "Data Encryption and Security", he could not attain the concerned PLOs 6 and 7. However, the student managed to clear these two PLOs in his FYP which gave him a better standing. The student was informed about his matter and was advised to repeat the same courses in their next offering for being assessed again for the same PLOs, and also to focus on taking those courses that map to these two PLOs. Currently in Fall 2020 semester, the student is studying "Engineering Ethics" which maps to both concerned PLOs (i.e. PLO 7 and PLO 11), for which the student will be evaluated for their attainment.

CQI over Intake 2017

In the data provided in Appendix A.29 *(SAR)*, it can be seen that several students of Batch 2017 are lagging in attaining the 60% PLO threshold at end of their 6th semester. This has been brought in to the notice of CQI Committee and several suggestions have been provided for the identified individuals as per the defined CQI process.

Table 5: Corrective Actions for students of Batch 2017 (End of Spring 2020).

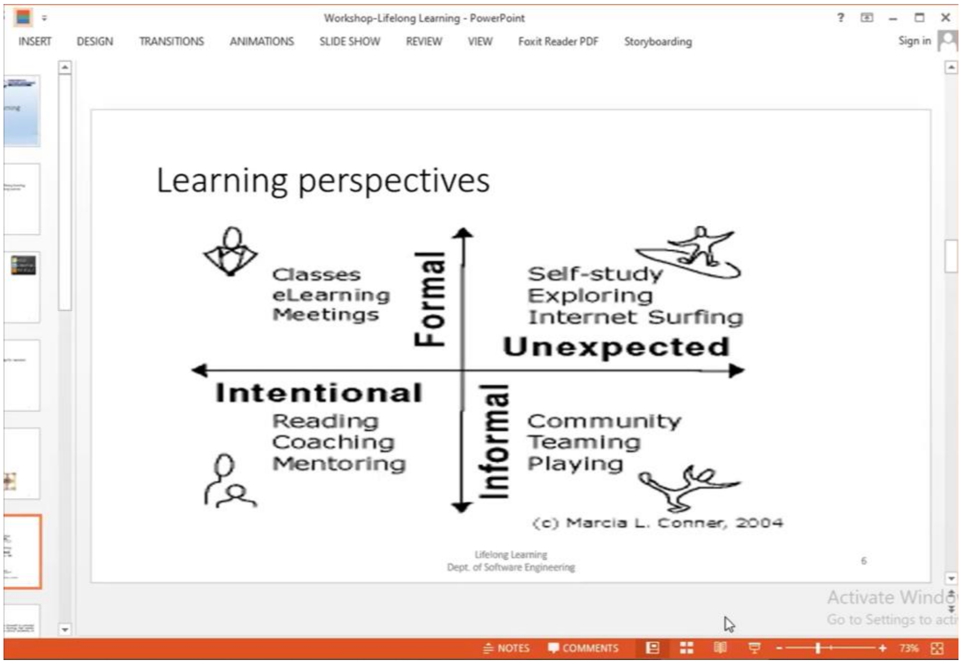
Students Name	PLOs Attainment at end of 6th semester	Corrective Actions taken as per suggested by CQI Committee

Faisal Mukhtar	PLO 6 = 50%	To help attaining PLO 6, the student was advised to take those courses that map to PLO 6. The student is currently taking “Entrepreneurship & Leadership”, “Engineering Ethics” and “FYP-I” where all three cover PLO 6.
Muhammad Asad	PLO 4 = 40% PLO 11 = 0%	To help attaining PLO 4, the student was advised to take those courses that map to PLO 4. The student is currently taking “Software Project Management”, “Data Encryption and Security” and “FYP-I” where all three courses cover PLO 4. To help attaining PLO 11, the student was advised to take those courses that map to PLO 11. The student is currently taking “Software Project Management” and “FYP-I” where both courses cover PLO 11.
Muhammad Uzair	PLO 6 = 50%	To help attaining PLO 6, the student was advised to take those courses that map to PLO 6. The student is currently taking “Entrepreneurship & Leadership”, “Engineering Ethics” and “FYP-I” where all three cover PLO 6.
Bisma Mohammad Akram	PLO 12 = 50%	To help attaining PLO 12, the QA committee has decided to assign the student a special task pertaining to Life-long learning to enhance her attainment.
Uzair Mehmood	PLO 8 = 57% PLO 12 = 50%	To help attaining PLO 8, the student is to repeat the course “Islamic Studies/Ethics” since he has failed in it. Passing the course will help in attaining the underlying PLO 8. On top of that, the student is studying “Engineering Ethics” which maps to PLO 8 as well. To help attaining PLO 12, the QA committee has decided to assign the student a special task pertaining to Life-long learning to enhance his attainment.
Amir Sohail	PLO 12 = 50%	To help attaining PLO 12, the QA committee has decided to assign the student a special task pertaining to Life-long learning to enhance his attainment.
Hamza Shahid	PLO 11 = 0%	To help attaining PLO 11, the student was advised to take those courses that map to PLO 11. The student is currently taking “Software Project Management” and “FYP-I” where both courses cover PLO 11.
Syed Ahsan Ali	PLO 11 = 0%	To help attaining PLO 11, the student was advised to take those courses that map to PLO 11. The student is currently taking “Software Project Management” and “FYP-I” where both courses cover PLO 11.
Aiman Shah	PLO 12 = 50%	To help attaining PLO 12, the QA committee has decided to assign the student a special task pertaining to Life-long learning to enhance his attainment.
Muhammad Noman Ali Siddique	PLO 7 = 0% PLO 11 = 0% PLO 12 = 50%	PLO 7 was not covered so far in his courses. However, the student is currently taking “Engineering Ethics” and “FYP-I” where both cover PLO 7. To help attaining PLO 11, the student was advised to take those courses that map to PLO 11. The student is currently taking “Software Project Management” and “FYP-I” where both courses cover PLO 11.

		To help attaining PLO 12, the QA committee has decided to assign the student a special task pertaining to Life-long learning to enhance his attainment.
Muhammad Osama Sami	PLO 4 = 50%	To help attaining PLO 4, the student was advised to take those courses that map to PLO 4. The student is currently taking “Software Project Management”, “Data Encryption and Security” and “FYP-I” where all three courses cover PLO 4.
Ahsan Mustafa	PLO 6 = 50%	To help attaining PLO 6, the student was advised to take those courses that map to PLO 6. The student is currently taking “Entrepreneurship & Leadership”, “Engineering Ethics” and “FYP-I” where all three cover PLO 6.
Gul Hameed	PLO 12 = 50%	To help attaining PLO 12, the QA committee has decided to assign the student a special task pertaining to Life-long learning to enhance his attainment.

From the analysis discussed above, it is noticed that a group of 6 students were lagging in attaining PLO 12. On top of that, it was speculated that future remaining subjects in the concerned roadmap may not address the underlying PLO. Hence, the QA committee has decided to assign the identified students with a special activity. As a result, an interactive workshop was conducted on the 14th November 2020 pertaining to PLO 12 by two senior faculty members at the Department of Software Engineering, namely Engr. Majid Kaleem and Engr. Muhammad Faisal. Several aspects were presented in detail to make students realize the importance of Life-Long Learning while providing several real-life examples and situations the students may encounter during their course of studies and in their professional life. To further strengthen the learning outcomes, students were given some real-life scenarios and asked to relate them with Life-Long Learning concepts. The discussion topics included:

- Define Learning
- Define lifelong learning
- Lifelong learning methods
- How to adopt lifelong learning in your life?
- Examples of lifelong learning
- Benefits of lifelong learning
- Importance of lifelong learning
- Role of Lifelong Learner



CQI over Intake 2018 & Intake 2019

No CQI process was executed on both these batches as per the policy adopted in 31st ACM of executing CQI process at end of 6th, 7th and 8th semester. However, PLO analysis were executed for these two batches for the sake of tracking the patterns generated out of student's performance.

End of Fall 2020 Semester

CQI over Intake 2017

At the end of Fall 2020 semester, the CQI process was only applicable on Intake 2017 as per the policy decided in 31st ACM. Generally speaking, out of the six students identified to be lagging in PLO#12 *(at end of Spring 2020 semester)*, five students have carried over their lagging issue till end of 7th semester since there was no course taken or offered to the student at their 7th semester that would map with PLO#12. Hence, it was generally decided to make sure that these five students would take at-least one course in their upcoming 8th semester that would map to PLO#12, where clearing it would help them in clearing PLO#12.

Corrective Actions for students of Batch 2017 (End of Fall 2020).

Students Name	PLOs Attainment at end of 7th semester	Corrective Actions taken as per suggested by CQI Committee
Bisma Mohammad Akram	PLO 12 = 50%	To help attaining PLO 12, the students were advised to take those courses that map to PLO 12. All five students have opted to take “Entrepreneurship and Leadership” and “FYP-II” courses where both courses cover PLO 12.
Amir Sohail	PLO 12 = 50%	
Aiman Shah	PLO 12 = 50%	
Gul Hameed	PLO 12 = 50%	
Muhammad Noman Ali Siddique	PLO 12 = 50%	

<u>CQI over Intake 2018, Intake 2019 & Intake 2020</u>

No CQI process was executed on all three batches as per the policy adopted in 31st ACM of executing CQI process at end of 6th, 7th and 8th semester. However, PLO analysis were executed for these three batches for the sake of tracking the patterns generated out of student’s performance.

End of Spring 2021 Semester

CQI over Intake 2017

At the end of Spring 2021 semester, the CQI process was applied on Intake 2017 which was at the end of their 8th semester. As per their PLOs attainment, all students have cleared their 12 PLOs and no student was found to be lagging in any of the PLOs. As a result, no CQI process was required to be executed on any student. Details of PLOs attainment obtained by all students of Intake 2017 by the end of Spring 2021 semester (i.e. end of their 8th semester) is provided in Appendix A.29 *(SAR)*.

CQI over Intake 2018

At the end of Spring 2021 semester, the CQI process was applied on Intake 2018 which was at the end of their 6th semester. As per their PLOs attainment, three students have been identified that are lagging below the 60% threshold as detailed in Table 7. This has been brought in to the notice of CQI Committee and several suggestions have been provided for the identified individuals as per the defined CQI process.

Corrective Actions for students of Batch 2018 (End of Spring 2021).

Students Name	PLOs Attainment at end of 6th semester	Corrective Actions taken as per suggested by CQI Committee
Muhammad Mujahid	PLO 1 = 44% PLO 2 = 43% PLO 3 = 31% PLO 4 = 50% PLO 5 = 40% PLO 8 = 22%	The student has not appeared in several final exams, failed in several other exams, frozen one semester and has an overall unsatisfactory performance since last several semesters resulting into not attaining several PLOs. The student was counselled several times and was encouraged to clear his courses along with his lagged-in PLOs. Hence, the committee has decided to only suggest him to clear his backlog

	PLO 9 = 44% PLO 10 = 50% PLO 11 = 25% PLO 12 = 33%	courses with a suitable pace. As a result, the student is currently enrolled in Fall 2021 in the following relevant courses: • Database Management System (PLO 1, 2, 3, 5, 8, 11) • Engineering Ethics (PLO 8) • Entrepreneurship & Leadership (PLO 1, 2, 12) • Pakistan Studies (PLO 8) • Software Requirement Engineering (PLO 1, 2, 3, 11) • Artificial Intelligence (PLO 1, 2 , 3, 5, 9, 11)
Umair Ahmed	PLO 1 = 44% PLO 2 = 41% PLO 3 = 35% PLO 4 = 0% PLO 5 = 50% PLO 6 = 50% PLO 8 = 50% PLO 10 = 44% PLO 11 = 0%	The student has not appeared regularly in classes nor exams since the last two semesters resulting into being failed in several courses and not attaining several PLOs. The student was counselled several times and was encouraged to clear his courses along with his lagged-in PLOs. Hence, the committee has decided to only suggest him to clear his backlog courses with a suitable pace. As a result, the student is currently enrolled in Fall 2021 in the following relevant courses: • Pakistan Studies (PLO 8) • Object Oriented Programming (PLO 1,3,5,11) • Entrepreneurship & Leadership (PLO 1, 2) • Engineering Ethics (PLO 6, 8) • Database Management System (PLO 1, 2, 3, 5, 8, 11) • Agile Development (PLO 1, 2, 3)
Muhammad Qasim Butt	PLO 7 = 0%	To help the student in attaining PLO#7, the student was advised to take courses that maps to PLO#7, such as “Engineering Ethics” and “FYP-I” where all these courses covers PLO#7. As a result, the student is currently enrolled in Fall 2021 in the following relevant courses: • Engineering Ethics (PLO7) • FYP-I (PLO7)

CQI over Intake 2019 & Intake 2020

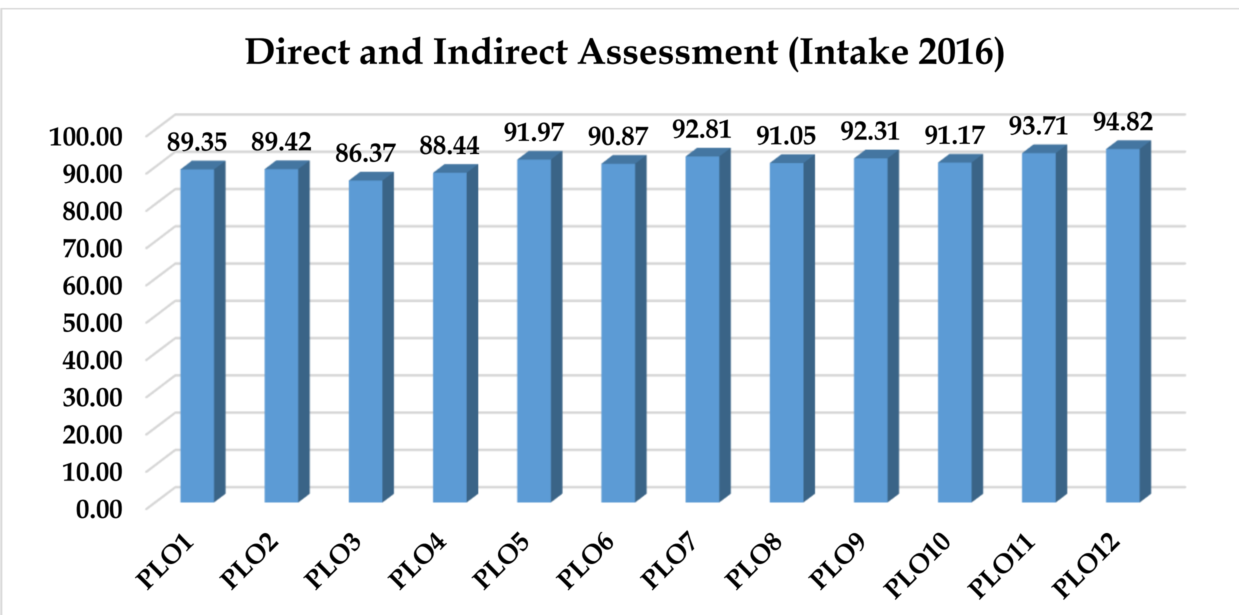
No CQI process was executed on both these batches as per the policy adopted in 31st ACM of executing CQI process at end of 6th, 7th and 8th semester. However, PLO analysis were executed for these two batches for the sake of tracking the patterns generated out of student’s performance.

2. **CQI in** Direct & **Indirect Assessment:**

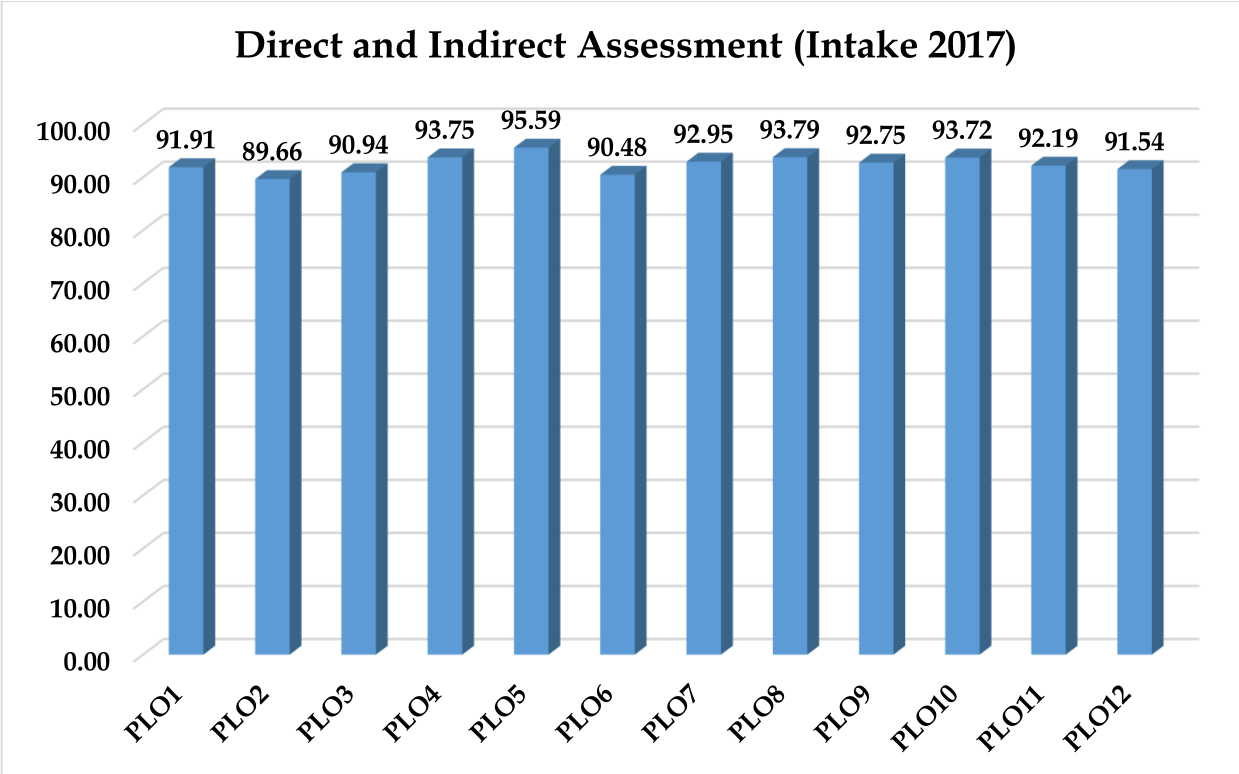
This combined approach of Direction & Indirect Assessment is used to evaluate performance of the complete cohort against each of the 12 PLOs and to decide on whether to take a corrective action on the formulation of concerned PLO or not. If the overall score of a cohort for a given PLO goes below the defined 70% threshold, then that specific PLO is brought under consideration of Departmental Board of Studies (DBoS). After identifying the reason for lack of attainment of PLO on a cohort level, it will further be discussed in Faculty Board of Studies (FBOS) then to Academic Council Meeting (ACM) of Bahria University. As per the process, any decision related with change in PLO can be taken by ACM only. In case a need arises for reviewing the existing PLOs which involves the addition, reduction of modification in the existing list of PLOs, initially CAC feedback shall be taken into account as well.

The QA Committee has executed the combined assessment approach while using both direct and indirect assessment tools over the last two passed-out Batches of Intake 2016 and Intake 2017. This was executed to deduce the PLOs performance of the batch while having input from different stakeholders, including students' course performance, internship providers' feedback, CSP providers' feedback and input from the graduating students themselves.

Details of the PLOs performance attained by intake 2016 and intake 2017 are presented in Appendix A.30 *(SAR)*. A summarized cohort attainment of PLOs through both direct & indirect assessments are presented by Figures below for Intake 2016 and Intake 2017. As shown in these two figures, all measured PLOs for both cohorts exceeds the defined threshold value of 70%, hence a successful attainment is achieved for both Batches and no corrective action was required.



Cohort-wise PLOs attainment for Intake 2016 using both direct and indirect assessment methods.



Cohort-wise PLOs attainment for Intake 2017 using both direct and indirect assessment methods.

Bachelors of Computer Engineering

Curriculum
2020

Departments of Computer Engineering

BAHRIA UNIVERSITY

Scheme of Studies

Duration	4 years
Number of Semesters	8
Number of weeks per semester	18 (16 for teaching and 2 for exams)
Total number of credit hours	136
Number of credit hours per semester	15-18
Non-Engineering Courses	16 Courses, 41 Credit hours, 30.15 % of total
Engineering Courses	27 Courses, 95 Credit hours, 69.85 % of total

Framework for Bachelor of Computer Engineering

Knowledge Profile (WK-1 to WK-8)	Knowledge Area	Sub-Area	Course Title	Theory	Lab	Total	Total Courses	Total Credit Area	Percentage	Overall
Non-Engineering Domain										
WK-7	Humanities	Culture	Islamic Studies / Ethics	2	0	2	2	15	36.59%	11.03 %
			Pakistan Studies & Global Perspective	2	0	2				
		English	Communication Skills	2	0	2	3			
			Functional English	3	0	3				
			Technical Writing	2	0	2				
		Social Sciences	Social Science Elective-I	2	0	2	2			
			Social Science Elective-II	2	0	2				
	Management Sciences	Professional Practice	MS-Elective-I	3	0	3	2	5	12.20%	3.68 %
			MS-Elective-II	2	0	2				
WK-2	Natural Sciences	Math	Applied Calculus & Analytical Geometry	3	0	3	6	21	51.22%	15.44 %
			Complex Variables & Transforms	3	0	3				
			Differential Equations	3	0	3				
			Linear Algebra	2	0	2				
			Numerical Analysis	2	1	3				
			Probability & Statistics	3	0	3				
WK-1		Physics	Applied Physics	3	1	4	1			
	Total Non-Engineering Domain			**39**	**2**	**41**	**16**	**41**	**100%**	**30.15 %**

Engineering Domain										
WK-2 / WK-4 / WK-5 / WK-6	Computer and Information Science	ICT	Computing Fundamentals	2	1	3	3	10	10.53%	7.35%
			Computer Programming	3	1	4				
			Discrete Structures	3	0	3				
WK-3 / WK-2	Engineering Foundation	-	Workshop Practices	0	1	1	8	29	30.53%	21.32%
			Digital Logic Design	3	1	4				
			Circuit Analysis	3	1	4				
			Electronic Devices & Circuits	3	1	4				
			Object Oriented Programming	3	1	4				
			Data Structures & Algorithms	3	1	4				
			Signals & Systems	3	1	4				
			Computer Architecture & Organization	3	1	4				
WK-4 / WK-1 / WK-2	Major Based Core (Breadth Courses)	-	Computer Communication & Networks	3	1	4	7	27	28.42%	19.85%
			Microprocessors & Interfacing	3	1	4				
			Operating Systems	3	1	4				
			Database Management Systems	3	1	4				
			Software Engineering	3	0	3				
			Digital Signal Processing	3	1	4				
			Digital System Design	3	1	4				
WK-5 / WK-6	Major Based Core (Depth Courses)	-	CEDE-I	3	1	4	4	16	16.84%	11.76%
			CEDE-II	3	1	4				
			CEDE-III	3	1	4				
			CEDE-IV	3	1	4				
WK-3 / WK-4 / WK-2 / WK-1	Multi-Disciplinary Engineering Courses	-	MDEE-I	3	0	3	3	7	7.37%	5.15%
			MDEE-II	3	0	3				
			Occupational Health & Safety	1	0	1				
WK-6 / WK-7 / WK-8	Final Year Design Project (FYDP)/Capstone	Industrial/Innovative/Creative Project	Project-I	0	3	3	2	6	6.32%	4.41%
			Project-II	0	3	3				

WK-6 / WK-7	Industrial Training (Summer)	At least 6 -8 weeks internship (summer)							
WK-2 / WK-4 / WK-5 / WK-6 / WK-7 / WK-8	Innovative & Critical Thinking (under relevant courses) - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open-Ended Labs - Problem-Based Learning (PBL)								
	Total Engineering Domain		**69**	**26**	**95**	**27**	**95**	**100%**	**69.85%**

Semester Wise Course Offering

S. No.	Pre-Req.	Course No.	Course Title	Theory Credits Hours	Lab Credit Hours	Total Credit Hours
Semester-I						
1	None	GSC 110	Applied Calculus & Analytical Geometry	3	0	3
2	None	ISL 101 /HSS 116	Islamic Studies / Ethics	2	0	2
3	None	CSC 110	Computing Fundamentals	2	1	3
4	None	GSC 113	Applied Physics	3	1	4
5	None	ENG 105	Functional English	3	0	3
6	None	EEL 112	Workshop Practices	0	1	1
			Total:	13	3	16

Semester-II						
1	None	GSC 120	Linear Algebra	2	0	2
2	GSC 113	CEN 121	Circuit Analysis	3	1	4
3	None	CSC 113	Computer Programming	3	1	4
4	None	PAK 103	Pakistan Studies & Global Perspective	2	0	2
5	None	ENV 101	Occupational Health & Safety	1	0	1
6	None	CEN 120	Digital Logic Design	3	1	4
			Total:	14	3	17

Semester-III						
1	None	CSC 115	Discrete Structures	3	0	3
2	GSC 113	EEN 224	Electronic Devices & Circuits	3	1	4
3	CSC 113	CSC 210	Object Oriented Programming	3	1	4
4	None	HSS 118	Communication Skills	2	0	2
5	GSC 110	GSC 220	Complex Variables & Transforms	3	0	3
6	-	-	Social Science Elective-I	2	0	2
			Total:	16	2	18

Semester-IV						
1	GSC 110	GSC 210	Differential Equations	3	0	3
2	CSC 210	CSC 221	Data Structures & Algorithms	3	1	4
3	None	EEN 313	Signals & Systems	3	1	4
4	CEN 120	CEN 221	Computer Architecture & Organization	3	1	4
5	-	-	MS-Elective-I	3	0	3
			Total:	15	3	18

Semester-V						
1	CEN 221	CSC 320	Operating Systems	3	1	4
2	ENG 105	HSS 321	Technical Writing	2	0	2
3	CEN 221	CEN 321	Microprocessors & Interfacing	3	1	4
4	EEN 313	EEN 325	Digital Signal Processing	3	1	4
5	None	CEN 223	Computer Communication & Networks	3	1	4
			Total:	14	4	18

Semester-VI						
1	-	-	CEDE-I	3	1	4
2	CSC 210	CSC 220	Database Management Systems	3	1	4
3	CSC 221	SEN 220	Software Engineering	3	0	3
4	None	GSC 122	Probability & Statistics	3	0	3
5	-	-	CEDE-II	3	1	4
			Total:	15	3	18

Semester-VII						
1	CEN 221	CEN 442	Digital System Design	3	1	4
2	None	HSS 423	MS-Elective-II	2	0	2
3	-	-	CEDE-III	3	1	4
4	-	ESC 498	Project-I	0	3	3
5	GSC 120	GSC 321	Numerical Analysis	2	1	3
			Total:	10	6	16

Semester-VIII						
1	-	ESC 499	Project-II	0	3	3
2	-	-	CEDE-IV	3	1	4
3	-	-	MDEE-I	3	0	3
4	-	-	MDEE-II	3	0	3
5	-	-	Social Science Elective-II	2	0	2
			Total:	11	4	15
			Grand Total:	108	28	136

Multi-Disciplinary Engineering Electives (MDEE) (6 Credit Hours)						
S. No.	**Pre-Req.**	**Course No.**	**Course Title**	**Theory Credits Hours**	**Lab Credit Hours**	**Total Credit Hours**
1	None	SEN 320	Human Computer Interaction	3	0	3
2	None	CEN 429	Introduction to Block Chain Technologies	3	0	3
3	None	CSC 449	Neural Networks & Fuzzy Logic	3	0	3
4	EEN 313	CEN 458	Robotics	2	1	3
5	None	CSC 341	Mobile Application Development	2	1	3
6	None	CEN 426	Introduction to Virtual Reality	3	0	3
7	None	SEN 420	Software Quality Assurance	3	0	3
8	EEN 224	CEN 457	VLSI Design	2	1	3
9	None	CSC 457	Data Mining & Warehousing	2	1	3
10	None	GEO 437	GIS & Remote Sensing	3	0	3
11	None	GEO 436	Health Safety & Environment	3	0	3
12	None	CEN 427	Biomedical Engineering	3	0	3
13	None	SEN 449	Business Process Automation	3	0	3
14	None	EEN 467	Control Engineering	3	0	3

Computer Engineering Depth Electives (CEDE) (16 Credit Hours)						
S. No.	**Pre-Req.**	**Course No.**	**Course Title**	**Theory Credits Hours**	**Lab Credit Hours**	**Total Credit Hours**
1	CSC 320	CEN 411	Cloud & Distributed Computing	3	1	4
2	CEN 321	CEN 449	Internet of Things	3	1	4
3	CEN 321	CEN 440	Embedded System Design	3	1	4
4	EEN 313	CEN 409	Artificial Intelligence & Machine Learning	3	1	4
5	CSC 320	CEN 444	Digital Image processing	3	1	4
6	CSC 113	CEN 408	System & Network Security	3	1	4
7	CSC 320	CEN 454	System Programming	3	1	4
8	CSC 320	CEN 407	High Performance Computing	3	1	4
9	CSC 221	CEN 326	Algorithm Design and Analysis	3	1	4
10	EEN 325	CEN 425	Hardware Design for DSP & ML	3	1	4

Management Science Electives (MS Elective - I) (3 Credit Hours)						
S. No.	**Pre-Req.**	**Course No.**	**Course Title**	**Theory Credits Hours**	**Lab Credit Hours**	**Total Credit Hours**
1	None	EMG 201	Engineering Project Management	3	0	3
2	None	MGT 423	Engineering Management	3	0	3
3	None	MTM 101	Introduction to Maritime Industry	3	0	3

Management Science Electives (MS Elective - II) (2 Credit Hours)						
S. No.	**Pre-Req.**	**Course No.**	**Course Title**	**Theory Credits Hours**	**Lab Credit Hours**	**Total Credit Hours**
1	None	EMG 222	Principles of Management	2	0	2
2	None	HSS 423	Entrepreneurship	2	0	2

Social Science Electives (SSE) (4 Credit Hours)						
S. No.	**Pre-Req.**	**Course No.**	**Course Title**	**Theory Credits Hours**	**Lab Credit Hours**	**Total Credit Hours**
1	None	HSS 412	Engineering Economics	2	0	2
2	None	HSS 413	Sociology for Engineers	2	0	2
3	None	HSS 424	Engineering Ethics	2	0	2
4	None	HSS 541	Organizational Behavior	2	0	2

Appendage 2517

Course Title: Distributed Generation Systems and its Grid Integration

Course Code: EEP 421

Credit Hours: 3+0

Pre-Requisite: None

Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs) Mapping:

CLO-1: Understand the basic operation, control and modelling of distributed energy systems (C1).

CLO-2: Analyse the characteristics of micro grid and impact of distribution source on the microgrid (C2).

CLO-3: Apply standards and grid codes for integrating distribution sources (C3).

	PLO-1	**PLO-4**	**PLO-12**
CLO-1	√		
CLO-2		√	

CLO-3			√

Objectives:

The course has been designed to help students understand the concept of distributed generation. The course will also enhance the skill of students to analyse the impact on grid integration & to study concept of microgrid and its configuration.

Contents: Introduction to distribution generation system, renewables application as distribution sources, concept of distributed generations, topologies, selection of sources, regulatory standards/ framework, Standards for interconnecting Distributed resources to electric power systems: IEEE 1547. DG installation classes, security issues in DG implementations. Energy storage elements. Requirements for grid interconnection, limits on operational parameters, voltage, frequency, THD, response to grid abnormal operating conditions, islanding issues. Impact of grid integration with NCE sources on existing power system: reliability, stability and power quality issues. Concept and definition of microgrid, microgrid drivers and benefits, review of sources of microgrids, typical structure and configuration of a microgrid, AC and DC microgrids, Power Electronics interfaces in DC and AC microgrids, Modes of operation and control of microgrid: grid connected and islanded mode, Active and reactive power control, protection issues, anti-islanding schemes: passive, active and communication based techniques, microgrid communication infrastructure, Power quality issues in microgrids, regulatory standards, Microgrid economics.

Text Book(s):

Integration of Distributed Generation in the Power System by Math Bollen And Fainan Hassan

Recommended Book(s):

Voltage Source Converters in Power Systems: Modeling, Control and Applications", Amir naserYezdani, and Reza Iravani, IEEE John Wiley Publications.

"Power Switching Converters: Medium and High Power", Dorin Neacsu, CRC Press, Taylor & Francis, 2006.

Course Title: Power System Economics

Course Code: EEP 422

Credit Hours: 3+0

Pre-Requisite: None

Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs) Mapping:

CLO-1: Understand the electric power sector regulation and compare different type of regulation (C1).

CLO-2: Analyse the concept of energy markets trusted to attain an adequate level of investment in generation capacity (C2).

CLO3: Compare the market regulation of generation from renewable energy sources with respect to generation from other sources and identify the reason of separate regulatory regimes. (C3).

	PLO-1	PLO-6	PLO-12
CLO-1	√		
CLO-2		√	
CLO-3			√

Objectives:

This course provides students with a good theoretical knowledge and understanding of power system economics. The basic principles of power system economics (main regulatory regimes and pricing principles) will be analysed in order to combine power system analysis and economic appraisal, providing an insight and ability to estimate future developments. Technical and economic implications of transition to a low-carbon energy systems will be discussed.

Contents: Power market fundamentals; pricing power, energy, and capacity; power supply and demand; Marginal cost in a power market; Market structure; Reliability and investment policy; reliability and generation; operating reserve pricing; requirement of installed capacity; Market architecture; day ahead market design; ancillary services; Market for operating reserves; defining Market power, modelling market power,

Text Book(s):

Power System Economics: Designing Market for Electricity by Steven Stoft

Recommended Book(s):

Fundamentals of Power System Economics by Daniel S. Kirschen, Goran Strbac

Course Title: Optimization Methods in Modern Power Systems

Course Code: EEP 423

Credit Hours: 3+0

Pre-Requisite: None

Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs) Mapping:

CLO-1: To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems (C1).

CLO-2: To analyse the optimum AC and DC power flow (C2).

CLO3: Use programming tool to solve various types of optimization problems (C3).

	PLO-1	PLO-2	PLO-5
CLO-1	√		
CLO-2		√	
CLO-3			√

Objectives:

Students will understand the operation of power networks from a control and optimization perspective. They will learn how mathematical tools and computational methods are used for the design, modelling, planning, and real-time operation of power grids.

Contents: Introduction to optimization, Meaning of optimization, Types of problems, Linear programming, Basic solution, Simplex method and LU decomposition, Unconstrained optimization, Minimization and maximization of convex functions, Gradient descent method, Method of steepest descent, Newton's method, Multi objective optimization problems, Evolutionary optimization algorithms, Economic Dispatch, DC Optimal Power Flow, AC Optimal Power Flow, Power optimization problems such as state estimation, unit commitment, optimal power flow, and transmission planning, Efficient optimization and numerical algorithms for mixed-integer nonlinear problems, Control and optimization for renewable energy, Unit commitment.

Text Book(s):

An Introduction to Optimization by E.K. Chong and S.H. Zak, Wiley-Interscience.

Recommended Book(s):

Convex optimization Stephen Boyd, and Lieven Vandenberghe, Cambridge university press, 2004.
Allen J. Wood, Bruce F. Wollenberg, and Gerald B. Sheble, Power Generation, Operation, and Control (3rd edition), Wiley, 2013.

Course Title: LV and HV Electrical Installation guides and Standards

Course Code: EEP 424

Credit Hours: 3+0

Pre-Requisite: None

Course Learning Outcomes (CLOs) and Program Learning Outcomes (PLOs) Mapping:

CLO-1: Interpret rules and regulation for electrical wiring comprising of cable selection and load calculation. (C1).

CLO-2: get knowledge for inspection and testing of electrical installation according to national and international standards (C2).

	PLO-1	PLO-8
CLO-1	√	
CLO-2		√

Objectives:

In this course student will understand the simple LV and HV electrical drawings, systems and testing. They will also develop the understanding and knowledge of safe systems of work, for tasks on or near electrical equipment at LV and HV level. Also, national and international standard for electrical installation will be taught.

Contents: Introduction to Electrical Safety, basic electrical theory, proving dead with approved methods and indicators, safe use of multi-meters and their limitations, Test leads to GS38 standard, Basic three phase principles – Single and three phase generation, Prospective fault currents, LV protection – Fuses, Circuit Breakers, Transformers, RCD's, Discrimination and diversity in electrical systems, Earthing methods and bonding and the importance of earthing, Induction motor operation, starting methods and testing, electrical test equipment – The safe use of the 'Megger', Capacitance and inductance in electrical circuits – Safety implications, Motor protection - Thermal, magnetic electro mechanical and electronic relays, Feeder, transformer and generator protection overview, Methods of achieving discrimination with time, magnitude and comparison, Understanding of the component parts in common electrical control panels - overloads, isolator, timers, relays, control, indication and power circuits, Reading and understanding schematic diagrams, Competence – familiarity with LV and HV installed systems, Safe systems of work for dead fault finding techniques and practice, Electric arcs awareness session, Switching sequences for HV systems – Precautions; dead, isolated and earthed; risks, identified, Document, methods, general safety, Switching procedure and instructions, Preparing exercises in syndicate groups, basic switching instructions and fault finding tasks, HV switching exercise

Text Book(s):

Electrical Installation Guide: According to IEC International Standards

Recommended Book(s):

Handbook of Electrical Installation Practice, Geoffrey Stokes

Appendage 2518

Power Stream:

Existing List of Depth Elective Course				Proposed List of Depth Elective Course			
Sr. No.	**Course Code**	**Course Title**	**Credit Hours**	**Sr. No.**	**Course Code**	**Course Title**	**Credit Hours**
1	EEN 316	Instrumentation and Measurements	3+1	1	EEN 316	Instrumentation and Measurements	3+1

2	EEP 441	Advanced Electrical Machines	3+1
3	EEP 442	Power Generation	3+1
4	EEP 443	Electrical Power Transmission	3+1
5	EEP 468	Power Electronics	3+1
6	EEP 444	Power System Protection	3+1
7	EEP 445	Power System Stability & Control	3+0
8	EEP 471	Electrical Machine Design and Maintenance	3+1
9	EEP 446	High Voltage Engineering	3+1
10	EEP 448	Renewable Energy Systems	3+0
11	EEN 325	Digital Signal Processing	3+1
12	EEP 472	Industrial Drives	3+1
13	EEP 475	FACTS and HVDC Transmission	3+0
14	CEN 223	Computer Communication & Networking	3+1
15	EEP 474	Smart Grid	3+0
16	EEN 437	Digital Control System	3+1
17	EET 474	Digital Communication System	3+1
18	EEN 469	Linear Integrated Circuits and Applications	3+1
19	EEP 474	PLC and Industrial Drives	3+1
20	EEN 445	Industrial Electronics	3+1
21	EEN 434	Computer Networks	3+1

2	EEP 441	Advanced Electrical Machines	3+1
3	EEP 442	Power Generation	3+1
4	EEP 443	Electrical Power Transmission	3+1
5	EEP 468	Power Electronics	3+1
6	EEP 444	Power System Protection	3+1
7	EEP 445	Power System Stability & Control	3+0
8	EEP 471	Electrical Machine Design and Maintenance	3+1
9	EEP 446	High Voltage Engineering	3+1
10	EEP 448	Renewable Energy Systems	3+1
11	EEN 325	Digital Signal Processing	3+1
12	EEP 472	Industrial Drives	3+1
13	EEP 475	FACTS and HVDC Transmission	3+1
14	CEN 223	Computer Communication & Networking	3+1
15	EEP 474	Smart Grid	3+0
16	EEN 437	Digital Control System	3+1
17	EET 474	Digital Communication System	3+1
18	EEN 469	Linear Integrated Circuits and Applications	3+1
19	EEP 474	PLC and Industrial Drives	3+1
20	EEN 445	Industrial Electronics	3+1
21	EEN 434	Computer Networks	3+1
22	EEP 421	Distributed Generation Systems and its Grid Integration (New Course with new code)	3+0
23	EEP 422	Power System Economics (New Course with new code)	3+0
24	EEP 423	Optimization Methods in Modern	3+0

		Power Systems (New Course with new code)	
25	EEP 424	LV and HV Electrical Installation guides and Standards (New Course with new code)	3+0
26	ESE 401	Energy Conservation and Auditing (New Course with new code)	3+0

Electronic Stream:

Existing List of Depth Elective Course

Sr. No.	Course Code	Course Title	Credit Hours
1	EEN 316	Instrumentation and measurement	3+1
2	EEN 462	Integrated Electronics	3+1
3	EEN 441	Industrial Process Control	3+1
4	EEN 442	Digital Electronics	3+1
5	EEN 444	Opto Electronics	3+1
6	CEN 452	VLSI Design	3+1
7	EEN 445	Industrial Electronics	3+1
8	CEN 442	Digital System Design	3+1
9	EEN 469	Linear Integrated Circuits & Applications	3+1
10	EEN 466	Introduction to Nano Technology	3+0
11	EET 451	Wave Propagation and Antennas	3+1
12	CEN 444	Digital Image Processing	3+0
13	EEN 435	Solid State Devices	3+1
14	EEN 437	Digital Control Systems	3+1

Proposed List of Depth Elective Course

Sr. No.	Cours Code	Course Title	Credit Hours
1	EEN 316	Instrumentation and measurement	3+1
2	EEN 462	Integrated Electronics	3+1
3	EEN 441	Industrial Process Control	3+1
4	EEN 442	Digital Electronics	3+1
5	EEN 444	Opto Electronics	3+0
6	CEN 452	VLSI Design	3+1
7	EEN 445	Industrial Electronics	3+1
8	CEN 442	Digital System Design	3+1
9	EEN 469	Linear Integrated Circuits & Applications	3+1
10	EEN 466	Introduction to Nano Technology	3+0
11	EET 451	Wave Propagation and Antennas	3+1
12	CEN 444	Digital Image Processing	3+1
13	EEN 435	Solid State Devices	3+0

15	EEN 433	Power Distribution and Utilization	3+1	14	EEN 437	Digital Control Systems	3+1
16	CEN 441	FPGA- Based System Design	3+1	15	EEN 433	Power Distribution and Utilization	3+1
17	EEN 420	Industrial Automation	3+1	16	CEN 441	FPGA- Based System Design	3+1
18	EEN 471	Microelectronics Technology	3+1	17	EEN 420	Industrial Automation	3+1
19	EEN 431	RF and Microwave Engineering	3+1	18	EEN 471	Microelectronics Technology	3+1
20	ESC 471	Biomedical Instrumentation	3+0	19	EEN 431	RF and Microwave Engineering	3+0
21	CEN 223	Computer Communication & Networking	3+1	20	ESC 471	Biomedical Instrumentation	3+0
22	ESC 472	Medical Robots	3+0	21	CEN 223	Computer Communication & Networking	3+1
23	CEN 458	Robotics	3+1	22	ESC 472	Medical Robots	3+0
				23	CEN 458	Robotics	3+1

Communication/ Telecommunication Stream

Existing List of Depth Elective Course				**Proposed List of Depth Elective Course**			
Sr. No	Course Code	Course Title	Credit Hours	**Sr. No**	**Course Code**	**Course Title**	**Credit Hours**
1	EEN 431	RF and Microwave Engineering	3+1	1	EEN 431	RF and Microwave Engineering	3+0
2	EET 463	Optical Fiber Communication	3+1	2	EET 463	Optical Fiber Communication	3+1
3	EET 447	Radar Systems	3+1	3	EET 447	Radar Systems	3+0
4	EEN 436	Wireless and Mobile Communication	3+1	4	EEN 436	Wireless and Mobile Communication	3+1
5	EET 449	Satellite Communications	3+1	5	EET 449	Satellite Communications	3+1
6	EET 451	Wave Propagation and Antennas	3+1	6	EET 451	Wave Propagation and Antennas	3+1
				7	EET 452	Multimedia Communications	3+0

7	EET 452	Multimedia Communications	3+1
8	CSC 453	Information Theory	3+1
9	EEN 434	Computer Networks	3+1
10	EET 411	Digital Communications	3+1
11	EET 456	Telecom Transmission and Switching Systems	3+0
12	CEN 444	Digital Image Processing	3+0
13	CEN 441	FPGA- Based System Design	3+1
14	EEN 469	Linear Integrated Circuits and Applications	3+1
15	EEN 316	Instrumentation and measurement	3+1
16	EET 471	Emerging Wireless Technologies and RF planning	3+0
17	EET 472	Telecommunication policies and standards	3+0
18	EET 462	Cryptography and Network Security	3+0
19	EET 459	Introduction to Block chain	3+0
20	ITC 411	Cyber Security	3+0

8	CSC 453	Information Theory	3+1
9	EEN 434	Computer Networks	3+1
10	EET 411	Digital Communications	3+1
11	EET 456	Telecom Transmission and Switching Systems	3+1
12	CEN 444	Digital Image Processing	3+1
13	CEN 441	FPGA- Based System Design	3+1
14	EEN 469	Linear Integrated Circuits and Applications	3+1
15	EEN 316	Instrumentation and measurement	3+1
16	EET 471	Emerging Wireless Technologies and RF planning	3+0
17	EET 472	Telecommunication policies and standards	3+0
18	EET 462	Cryptography and Network Security	3+0
19	EET 459	Introduction to Block chain	3+0
20	ITC 411	Cyber Security	3+0

Appendage 2519

The existing marks distribution in the FYP Final Defense is given below:

Final Year Evaluation Deliverables	**Marks**
i. Final Project Defense Presentation / Demonstration	
• Internal Examiner Evaluation	15
• External Examiner Evaluation	15
ii. FYP Supervisor Evaluation	30
iii. FYP Coordinator Evaluation	10
iv. Complete FYP Report+ Plagiarism Report	Non Graded
v. 24 Log Book Entries (Showing students-supervisor meetings)	Non Graded
vi. Hardware / Software (Code + Data) Submission	Non Graded
vii. Ethics (Following timeline/deadlines)	Non Graded
viii. CVs of all FYP Members	Non Graded

ix.	Brochure and Panaflex of FYP (According to the given Template)	Non Graded

The proposed changes in the FYP Final Defense are given below:

Final Year Evaluation Marks Distributions	**Marks**
i. Final Project Defense Presentation / Demonstration	
• Internal Examiner Evaluation	15
• External Examiner Evaluation	15
ii. FYP Supervisor Evaluation	30
iii. FYP Coordinator Evaluation	10

Following FYP Deliverables will be evaluated by all Evaluators.

Complete FYP Report+ Plagiarism Report
24 Log Book Entries (Showing students-supervisor meetings)
Hardware / Software (Code + Data) Submission
Ethics (Following timeline/deadlines)
CVs of all FYP Members
Brochure and Panaflex of FYP (According to the given Template)

Pakistan Engineering Council

(Constituted under Pakistan Engineering Council Act, 1976 enacted by the Parliament)

Engineering Accreditation Department (EAD)

Ataturk Avenue (East), G-5/2, Islamabad

PEC/EAD/40-GB/004/2021
May 21, 2021

All Vice Chancellors/ Rectors/ Heads
HEIs in Pakistan

Subject: **Permission for Appearance of Students in the Exam to Complete Their Degrees in more than Seven (07) Academic Years**

Dear Sir/ Madam

The PEC Governing Body in its 40th meeting held on February 10, 2021, deliberated on Article 5(b) of PEC Regulations of Engineering Education in Pakistan and the decision made is as under;

> *"It was concluded that relaxation be granted to all those students for further three years up to December 31, 2023, who failed to complete their degree within seven years of time."*

2. In light of above decision, all such students who could not complete their degree may please be approached to complete their degrees before 31-12-2023.

3. This is for information and compliance/ adherence, please.

(Engr. Dr Ashfaq Ahmed Sheikh)
Additional Registrar/ Head EAD

Copy to:

a. The Convener-EAB
b. Section Heads (Zone I,II & III)
c. PS to Chairman/ Registrar

Direct: 051-2829296, 9206974, Fax: 051-2276224
Website: http://www.pec.org.pk Email: drashfaq@pec.org.pk

Lab Grading Scheme is as follows:

Existing		Proposed	
Continuous Assessment (14 Labs)	40	Continuous Assessment (13 Labs)	52
Mid Evaluation	20	Open Ended Lab	6
Lab Journal	20	Mid Evaluation	12
Final Evaluation/Project/Viva	20	Final Viva	10
		Project	20

Bahria University
Discovering Knowledge

BU-HO/DHR/2021/L/1487

DG-IC
BUIC - BU Islamabad

DG-KC
BUKC - BU-Karachi

DG-NIMA
NIMA - NIMA

DG-BUMDC
BUMDCKC - BUMDC

21 August 2021

PAYMENT OF PH.D & M PHIL/MS ALLOWANCES - POLICY

1. Competent Authority has revised the PhD and M Phil Allowances w.e.f. 01 July 2021 as per the HEC Policy as follows:

   a. Ph.D Allowance Rs. 10,000/- PM

   b. MS/M.Phil Allowance Rs. 2500/- PM

1. Payment of Ph.D & MS/M.Phil allowances is to be implemented as follows:

2. a. In case of those individuals who joined BU after 01 July 2021 or attained higher qualification after joining BU, their Ph.D or MS/ M.Phil Allowance will be shown separately in their pay slips.

   b. For individuals hired in past whose MS/ M.Phil Allowance is not shown in their pay-slips, status quo is to be maintained

   c. Individuals who are getting Rs 6000/-PM as MS/ M.Phil allowance will continue to draw same amount as part of pay protection. However, In their pay slip Rs 2500/ PM is to be mentioned as MS/ M.Phil allowance whereas Rs 3500/- PM as Special Allowance.

   d. Only one allowance will be admissible i.e. those getting Ph.D Allowance will not get MS/ M.Phil Allowance.

   e. Ph.D Allowance for those candidates who completed their Ph.D after joining BU will be admissible from date of notification of Ph.D.

   f. M.Phil Allowance for those candidates who completed their MS/ M.Phil after joining BU will be admissible from the date (month) of receipt of application at BUHO. Campuses/ Departments are to ensure that such requests are forwarded expeditiously to BUHO (HR Dte). For cases in process/ new cases, M.Phil Allowance will be paid as per the revised rates of Rs. 2500/- PM.

3. This Policy is implemented w.e.f. 01 July 2021. All previous instructions on the subject stand cancelled.

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Letter Details

Back to Home

Bahria University

BU-HO/DHR/2021/L/2295

Director Campus - BUMDC
BUMDCKC - BUMDC

Director - H-11
BUIC - BU Islamabad

Director NIMA Karachi
NIMA - NIMA

Director - BULC
BULC - BU Lahore

Director IPP
IPP - IPP

Director - BUIC
BUIC - BU Islamabad

Director NIMA Islamabad
NIMA - NIMA

Director - BUKC
BUKC - BU-Karachi

02 December 2021

POLICY - PH.D & M PHIL ALLOWANCES

Reference(s):

A. BU-HOLetterBU-HO/DHR/2021/L/1487 dated 21 Aug 2021

1. Apropos Ref A , Competent Authority has revised the Ph.D and M. Phil Allowances as per the HEC Policy as follows:
   a. Ph.D. Allowance   Rs. 10,000/- PM
   b. M.Phil Allowance   Rs. 2,500/- PM
2. Payment of Ph.D & M.Phil Allowances is to be implemented as follows:
   a. Ph.D and M.Phil Allowance @ Rs. 10,000 and Rs. 2,500 respectively will be shown separately in pay slips.
   b. Only one allowance will be admissible i.e. those getting Ph.D Allowance will not get M.Phil Allowance.
   c. Ph.D and M.Phil allowances for those candidates who completed their Ph.D/ M.Phil after joining BU will be admissible from the date of notification.
   d. For individuals whose M. Phil Allowance (in few cases MS Allowance) is shown or otherwise in their pay slips, status quo is to be maintained.
   e. Ex-PN officers will not be eligible for Ph.D/M.Phil allowance except those who are on Faculty Contract.
3. This Policy is implemented with **immediate effect**.
4. All previous instructions on the subject stand cancelled.

ZAHID AKRAM SI(M), S.Bt
Commodore (R)
Director Human Resource

HIGHER EDUCATION COMMISSION
H-9, Islamabad (Pakistan) Phone: (051) 90802750, Fax: (051) 90802753
E-mail: ismaeel@hec.gov.pk

Muhammad Ismail
Consultant (Quality Assurance Division)

Ref. 1-1 (NQF)/QAD/2017/HEC/ 49-/
Date: May 23, 2017

Subject: **Grant of MPhil Allowance @ Rs. 2500/- Per Month**

1. Reference to F.No.3(6)Imp/2016-Vol-II-4 dated January 04, 2017 on subject cited above.

2. Under the provision of Section 10 clause 1(o) of HEC's Ordinance No. LIII, dated 11.09.2002, the Quality Assurance Division of HEC has devised the Admission and Award of Degree Criteria for MS/MPhil/PhD/Equivalent Programs. As per HEC approved criteria (enclosed), there is no difference between MS and MPhil degrees except nomenclature. As such, there are two types of MS/MPhil Degrees that are mentioned below:

   a. MS/MPhil by Course Work (30 credit hours)
   b. MS/MPhil by Thesis (24 credit hours course work + 06 credit hours thesis)

3. It is further added that in some cases, nomenclature was changed from MPhil to MS after the introduction of BS and MS programs by HEC. As such following types of degrees are awarded as equivalent to 18 years of schooling:

S#	Degree Title	Description
i	a. MPhil Degree (with thesis) b. MS Degree (with thesis)	Both are equal degrees, awarded after 24 credit hours course work + 06 credit hours thesis. There is no difference except nomenclature.
ii	a. MPhil Degree by Course Work b. MS Degree by Course Work	Both are equal degrees, awarded after 30 credit hours course work. There is no difference except nomenclature.
iii	Equivalent degrees of Other disciplines like Engineering, Agriculture, Law, MBA, etc.	In these disciplines, degrees are not awarded with MS/ MPhil Title while these degrees are equated to 18 years of schooling.

4. According to above referred Office Memorandum of Govt. of Pakistan, Finance Division, the MPhil allowance is granted to those only who acquire/possess the degree of MPhil recognized by the HEC. However, in view of the above mentioned clarification, all those who have MPhil or MS degrees (18 years schooling) should be eligible to draw the allowance @ Rs. 2500/- per month.

5. Forwarded for your favorable consideration, please.

With kind regards,

mIsmail
(Muhammad Ismail)

Enclosure: **as above**

Mr. Faisal Nadeem
Accounts Officer (Imp),
Government of Pakistan, Finance Division (Regulations Wing), Islamabad
FBC Building, Near State Bank of Pakistan.