Minutes of the 14th Meeting of
Faculty Board of Studies (FBoS) Engineering Sciences

Contents

Minutes of the 14th Meeting
Faculty Board of Studies (FBoS) Engineering Sciences
held on 6th & 20th February 2018 by VLC

Attendance:

BUIC

Present

• Prof Dr. M. Najam ul Islam	Dean ES	Chair
• Prof. Dr. Tahseenullah Khan	HOD(E&ES)	Member
• Associate Prof. Dr. Atif Raza Jafri	HOD(EE)	Member
• Associate Prof. Dr. Faisal Bashir	HOD(CS)	Member
• Associate Prof. Dr. Awais Majeed	HOD(SE)	Member
• Associate Prof. Dr. Amina Jameel	HOD(CE)	Member

BUKC

Present

• Prof. Dr. Haroon Rasheed	HOD(EE)	Member
• Associate Prof. Dr. Humera Farooq	HOD(CS)	Member
• Associate Prof. Dr. Sohaib Ahmed	HOD(SE)	Member
• Asstt. Prof. Dr. Rizwan Iqbal	HOD (CE)	Member
• Dr. Moazzam Fareed Niazi	HOD SE	Member (Acting HOD on 20th Feb)

BULC

• Asstt. Prof. Mr Farhan Saeed Sherazi	HOD(CS&IT)	Member

In Attendance

• Prof. Dr. Muhammad Zafar	E&ES	BUIC
• Dr. Junaid Imtiaz	EE	BUIC

Proceedings

1. FBoS-ES meeting took place on two days; in first session, with the quorum complete, the proceedings commenced at 1300 hrs, with recitation from the Holy Quran on 6th February, 2018.

2. The second session of FBoS took place on 20th February, 2018, with the quorum complete; the proceedings commenced at 1000 hrs, with recitation from the Holy Quran, recessed for lunch and namaz at 1300 hrs, resumed proceedings at 1400 hrs and continued till 1700 hrs.

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

Confirmation of the Minutes of the 13th FBOS -ES held on 10th August, 2017

The Minutes of the 13TH FBoS-ES were then tabled for confirmation. The members from all the campuses endorsed the minutes upon which the House confirmed the minutes.

New Items:

Item 1401: Amendments in MPI course outline as per requirement of PEC (EE-BUIC)	
Sponsor: HOD EE BUIC	Referral Authority: DBOS EE BUIC

Summary of the Case

In reference to the observations made by PEC, EE Dept BUIC revised the course and lab outline of MPI course to include the contents of both microcontrollers and microprocessors. Revised course outlines are placed at (Appendage 1401).

Discussion

EE BUKC was satisfied with the existing course outline, since no such observations were made by PEC during the visit at EE BUKC. HOD EE BUKC further added that FYPs at their Dept mostly includes microcontrollers rather than microprocessors. The house supported the agenda item with remarks that microprocessor is an important domain to study and there are chances that it will be pointed out by PEC in upcoming visits. The board asked the sponsor to review the proposed course outline and send revised course outline again.
EE-BUIC reworked the outlines, presented in the 2nd session and the house approved.

Decision 1401

1. The proposed revision in course and lab outline approved.
2. The departments are at liberty to change course outlines or contents of a course up to 20% as per their requirements and with the approval of concerned Cluster Head.

Action Required	Action by	Responsibility of
Implementation of the Decision	HODs EE	HOD EE BUIC
Statutory Documents affected: Curricula		

Item 1402: Curriculum of Electrical Engineering for Bachelor and Master Degree Programs (EE BUIC)	
Sponsor: HOD EE BUIC	Referral Authority: DBOS EE BUIC

Summary of the Case

With reference to preliminary meeting of National Curriculum Revision Committee (NCRC) in the discipline of Electrical Engineering for Bachelor's and Master's Degree programs held during Fall' 16 at the Higher Education Commission (HEC), Regional Centre Peshawar. The Electrical Engineering curriculum (2012) for Bachelors and Master Degree Programs was revised according to indigenous needs and to fulfill needs of Outcomes Based Education (OBE).

Discussion

HOD EE BUIC presented and iterated the case. After a brief discussion, the house deferred the agenda item, till HEC (NCRC) either sends the document to the university or uploads on website the revised curriculum for Electrical Engineering programs.

Decision 1402

Agenda item deferred.

Item 1403: Updated EE Department Framework for OBE implementation (EE BUIC)

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

Summary of the Case

For OBE system implementation on BEE Program, there is need to have clear vision at university and departmental level, mission at university and program level, program educational objectives, program learning outcomes, course learning outcomes and their mapping. As part of CQI there is need to develop KPIs for PEOs, PLOs and CLOs. Proposed item details are placed at Appendage 1403.

Discussion

After detailed discussion, with few suggestions and amendments, agenda item approved.

Decision 1403

The house forwarded the proposal to ACM for approval.

Item 1404: OBE implementation framework for Engineering Programs at BU

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

Summary of the Case

OBE implementation demands to devise and establish a framework to implement CQI process which is an integral part of OBE system. The proposed OBE implementation frame work is placed at Appendage 1404.

Discussion:

HOD EE BUKC and HOD SE BUIC suggested enhancing the role of CAC in CQI process, moreover, the FBoS chair emphasized to define clear role of teacher, student and cluster head in CQI process. After detailed discussion, FBoS recommended the item for ACM with major revisions.

Decision 1404:

The house decided to formulate a consolidated OBE implementation framework for Engineering Programs (by merging the agenda items sent by the DBoSs of Engineering Departments at Islamabad and Karachi Campuses), to be presented in ACM for approval by Dean – ES.

Item 1405: Process of Establishing and Reviewing PEOs, PLOs and CLOs (EE BUIC & BUKC)

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

Summary of the Case

Different KPIs are set for direct/ indirect assessment of attainment of each PEO. Following are the recommended Key Performance Indicators for each PEO.

a. **PEO 1**
   - 70% of the graduates are gainfully employed in the electrical engineering related industry within one year of graduation.
   - 5% of the graduates have started their own businesses or startups within one year
   - 5% of the graduates are employed in other fields unrelated to electrical engineering within one year.

b. **PEO 2**
   - 65% to 70% of the employers in the electrical industry are satisfied with the technical competence of EE graduates 6 months after being hired.

c. **PEO 3**
   - 15 to 20% of graduates have secured admission in MS or PhD programs within one to three years after graduation either within Pakistan or abroad.
   - 30% of the graduates have attended at least one professional development course in the last one year.
   - 25% graduates have acquired one new skill, or learnt a new tool in the last one year.
   - 15% of graduates have appeared in any scholarship related examination like NTS, GRE or applied for international scholarships like Full bright, commonwealth, or HEC etc.

d. **PEO 4**
   - 25% of graduates have assumed leadership / managerial positions in their industry in five years.
   - 20% of graduates are part of any voluntary organization working for the betterment of society within 2 years of graduation.
   - 5% of graduates have received some recognition for their social, environmental or humanitarian work either in Pakistan or abroad.

Process of Reviewing CLOs:

- A Performa for CLO checking should be designed.
- CLOs will be checked after result declaration.
- Discuss with Cluster heads.
- If any CLO needs revision it will follow the CQI assessments mechanism.

Process of reviewing PLOs:

- It was decided to use the already published PLOs in PEC Accreditation Manual 2014 should be taken as it is.
- The above mentioned PLOs can be changed on the bases of CQI corrective measurements after approval from higher authorities.

Discussion

The FBoS suggested revisiting and making KPIs flexible.

Decision 1405

The proposed KPIs and process of establishing and reviewing PEOs, PLOs and CLOs for BEE programs at BU was approved and are listed below, however, implementation of the agenda item is subject to the OBE framework approval from ACM.

a. **PEO 1**
   - 50% of the graduates are gainfully employed in the electrical engineering related industry within one year of graduation.

- 10% of the graduates have started their own businesses/startups or employed in other fields within one year.

b. PEO 2

- 60% of the employers in the industry are satisfied with the technical competence of EE graduates 6 months after being hired.
- 5% of the graduates have presented their work at technical forums such as conference, journal, symposium, technical competitions.

c. PEO 3

- 15 to 20% of graduates have secured admission in MS or PhD programs within one to three years after graduation either within Pakistan or abroad.
- 20% of the graduates have attended at least one professional development course after graduation.

d. PEO 4

- 15% of graduates have assumed leadership / managerial positions in their industry in four years.
- 15% of graduates are part of any voluntary organization working for the betterment of society within 4 years of graduation.

Process of reviewing PLOs:

The process of reviewing PLOs shall be based on the data collected from Internship Survey Forms, CSP Feedback, Parents Feedback, Exit Forms. A PLO shall be revisited in case an overall satisfactory level of that PLO goes below 70%.

Process of Reviewing CLOs

The process of reviewing CLOs shall be based on the data collected from Individual survey summary, Course Review Report by Instructor, CLOs based Result Assessments. A CLO shall be revisited in case an overall satisfactory level of that CLO goes below 70%.

Item 1406: Clearing/Passing PLOs and CLOs in order to attain Graduate Status for Engineering Department (EE BUKC)

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

Summary of the Case

The sponsor presented the case and emphasized on defined criterion for clearing /passing CLOs and PLOs in order to attain graduate status for engineering department.
Following recommendations were made in this regard

1. A CLO shall be cleared if a student takes at least 50% marks in that CLO.
2. In order to clear a PLO 60% CLOs relate to that PLO should be cleared.
3. If failed to do so, the student needs to take one Week Workshop on that specific PLOs domain.
4. The respective PLO workshop shall be held during 7th and 8th Semester break for Students of graduating batch.
5. In case the student has acquired the requisite marks to attain his degree based on CGPA, and failed to clear all PLOs, workshops will be arranged.

Discussion

The sponsor presented and reiterated the case, after detailed discussion FBoS suggested to review the item again and present with minor modifications in the second session. The revisions were presented in the second session of the FBoS and were approved.The recommendations were made part of OBE implementation framework.

Decision 1406

The house approved the item.

Action Required	Action by	Responsibility of
Implementation of the Decision	HODs EE	HOD EE BUKC
Statutory Documents affected: -		

Item 1407: Inclusion of lab component in elective courses of BSE road map (SE BUKC)

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

Summary of the Case

In compliance to the latest PEC report, lab components are required to be increased in the Software Engineering (SE) program at Bahria University Karachi Campus (BUKC). To achieve that, several discussions and meetings were held within the department of Software Engineering (SE), BUKC. In addition, the matter was discussed with Department of Software Engineering at Bahria University Islamabad Campus (BUIC). Total credit hours offered in each semester and throughout the degree program will remain unaffected.

After going through the existing roadmap of SE program at Bahria University, lab components have been added to the following five courses (details of lab titles are provided in Appendage 1407:

- Total number of credit hours for each of the underlying five courses will remain the same after adding the lab components, i.e. 3 Cr Hrs. As a result, total number of credit hours at the effected semesters will also remain the same.
- Credit hours distribution for the underlying five courses shall be converted from (3+0) to (2+1).

1. SEN-421 Semantic Web
2. SEN-326 Advanced Database Management System
3. SEN-328 Game Application Development
4. CEN-458 Robotics
5. CSC-452 Data Mining

Discussion

The chair suggested making road map simpler to avoid any ambiguities. After detailed discussion, the house approved the roadmap with minor changes.

Decision 1407

The house approved the item; the chair further suggested adding these changes in revised roadmap to be presented in ACM for approval.

Action Required		Action by	Responsibility of
Implementation of the Decision		HODs SE	HOD SE BUKC
Statutory Documents affected:		Roadmap, Curricula	

Item 1408: Addition of Elective Courses in MS roadmap. (SE,EE & CS BUIC)

Sponsor: HOD (SE , EE & CS)BUIC | Referral Authority: DBOS (SE ,EE & CS) BUIC

Summary of the Case

To meet the current trends and market requirements, elective courses are proposed by CS,SE and EE to be added to the MS road map.

Discussion

Following elective courses were presented before FBoS to be added to the MS road map , detailed course outlines are placed at appendage 1408. The FBoS chair commented that, since HEC has recently issued revised curriculums, therefore, HODs are advised to propose again the elective courses in next FBoS.

Ser.No	Course Name	Course Code	Department/Program
1.	Data Science Foundations	DSC-501	CS-BUKC
2.	Distributed Data Engineering	DSC-704	CS-BUKC
3.	Deep Learning and Data Analysis	DSC-705	CS-BUKC
4.	Modeling and Control of Power Converters	EEP-780	EE-BUIC
5.	Power Cable Engineering	EEP-781	EE-BUIC
6.	Distributed Generation & Microgrids	EEP-782	EE-BUIC
7.	Advanced Digital Control systems	EEN-731	EE-BUIC
8.	LTE Mobile Communication Systems	EET-771	EE-BUIC
9.	Radio Resource and Spectrum Management	EET-772	EE-BUIC
10.	Advance Wireless Systems Design	EET-773	EE-BUIC
11.	Deep Learning for Pattern Recognition	CSC-785	CS-BUIC
12.	Empirical Software Engineering	SEN 757	SE-BUIC
13.	Intelligent Tutoring System	CSC 750	SE-BUIC

Decision 1408

In view of the revised roadmaps updated by HEC for CS, SE, and EE (expected Spring'2018), the house pended the item till next FBOS.

Item 1409: Reducing absence relaxation to 20% from 25% in Engineering Sciences. (CS BULC)

Sponsor: HOD (CS) BULC | Referral Authority: FBOS MSS

Summary of the Case

The sponsor emphasis to reduce absence relaxation to 20%. However, further 5% may be kept as special case only for following reasons

a. Death of parent or any blood relation.
b. Hospitalization of self or relations mentioned in a.
c. Umra / Hajj

Discussion

The house argued that the current policy is aligned with HEC policy and change in the existing policy shall not be much beneficial. The departments at Karachi and Islamabad didn't support the proposal specially the 5% attendance clearance at department level.

Decision 1409

FBoS didn't approve the agenda item. Point dropped.

Item 1410: Launch of MS Data Science (CS BULC)

Sponsor: HOD (CS) BULC | Referral Authority: DBOS CS BULC

Summary of the Case

The case proposed launching of a MS program in Data Science that would also open more avenues for the large number professionals and researchers who aims to continue their study at higher level.

Discussion

The FBoS emphasized that launching MS program is a huge responsibility, complete feasibility is required. Moreover, pre-requisites to launch a program are not fulfilled yet (Hiring of PhD faculty). The Chair suggested of hiring at least two PhD faculty members in computer science with specialization in Data Sciences before forwarding the case to ACM & HEC.

Decision 1410

FBoS pended the item till hiring of at least two relevant PhD faculty members in the department.

Action Required	Action by	Responsibility of
Implementation of the Decision	HOD CS BULC	HOD CS BULC
Statutory Documents affected:		

Item 1411: Revision of Program Educational Objectives (PEOs) for OBE implementation (CE BUIC)

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

Summary of the Case

The sponsor presented the Computer Engineering PEOs before the house for recommendation. The proposed PEOs are placed at Appendage 1411.

Discussion

The sponsor presented the agenda item; HOD CS BUIC enquired about PEOs and their implementation mechanism which was explained by the sponsor quite convincingly. The chair recommended few changes which were later supported by the house.

Decision 1411

The proposed agenda item was found on merit and forwarded to ACM for approval.

Item 1412: CQI process for PEOs in OBE implementation (CE BUIC)

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

Summary of the Case

PEOs are designed to address the requirements and expectations of the various stakeholders. The PEOs describe the expected accomplishments of graduates after four (4) years graduation. The achievement of PEOs ensures the successful implementation of CLOs and PLOS, for this purpose CQI committee of CE department has tailored a comprehensive CQI process with various activities/ actions, details of which are placed at Appendage 1412.

Discussion

After detailed discussion and arguments, the FBoS found the item on merit.

Decision 1412

FBoS decided to formulate a consolidated OBE implementation framework for Engineering Sciences, to be presented in ACM for approval.

Action Required	Action by	Responsibility of
Implementation of the Decision	HOD CE, EE & SE	Dean ES
Statutory Documents affected:		

Item 1413: Launch proposal of four years BS (Automation and control) and BS (Energy and Power) evening program (EE BUKC)

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

Summary of the Case

The case proposed launch of two BS programs at BUKC, the sponsor advocated his proposal by commenting that BUKC will be trend setter to launch four years (non-engineering) BS (Automation and control) and BS (Energy and Power) programs. Moreover, the department exhibits strength in terms of faculty and labs requirements to start and manage the program appropriately with existing resources.

Discussion

The sponsor presented and reiterated the case; the FBoS chair enquired that how is the proposed program different from existing engineering programs. The sponsor supported his proposal by commenting that less PEC binding will give us flexibility in using our resources, moreover, there are few universities like COMSATS & IQRA having similar structure. The board found that the proposed programs are not much different from the existing engineering programs and there are authorities like NTC to regulate and monitor non-engineering programs.

Decision 1413

HoDs of EE at KC and IC to work for the regularity requirements. Dean and HoD-EE-KC are to discuss the case further with campus management at KC. The case is pended till further discussion with campus management.

Item 1414: Policy and implementation in CMS of pre-requisite courses in MSEE Program (EE BUKC)

Sponsor: HOD EE BUkC Referral Authority: DBOS EE BUKC

Summary of the Case

As per eligibility criteria of MSEE program, several students other than BE/BS-EE or equivalent degrees can apply for admission. In admission eligibility criteria it is mentioned, “Graduates from other disciplines or 16 years degree in Computer Science, Electronics, Physics or any other discipline may be eligible for this program, subject to passing pre-requisites with minimum GPA 3.0/4.0 in each course as per recommendation of Departmental Graduate Committee”.
However, admission department has no such provision, policy or rule to induct such students, moreover, CMS should be modified to accommodate such students.
The sponsor proposed following recommendations to solve the issue

1. Potential students may be allowed to take courses in morning without paying any fee.
2. Potential student may be allowed to take audit course without midterm and final term exams.
3. Potential students may be allowed to take courses with full fee and on completion of course with required GPA, a certificate may be granted.

Discussion

HOD CS BUIC supported the item by commenting that same practice is observed in NUST with enrollment limit on number of deficiency courses per semester. The members of the board highlighted the similar issue / challenge with eligibility criteria of MS programs in FoES. The house observed that same issue can be faced in other departments as well.

The board chair suggested formulating a committee to define a list of pre-requisite courses for each program, and clearing those courses will be necessary, if not studied in BS or equivalent programs. The chair further added that maximum of three courses should be allowed to be studied with undergraduate program.

Decision 1414

The chair constituted the following committee to prepare a list of mandatory pre-requisite courses and to modify the eligibility criteria of MS Programs in FoES if deemed necessary:

i. Prof. Dr. Haroon Rasheed HOD EE BUKC, Chair
ii. Dr. Amina Jameel HOD CE BUIC
iii. Dr. Faisal Bashir HOD CS BUIC
iv. Dr. Awais Majeed HOD SE BUIC
v. Dr. Sohaib Ahmed HOD SE BUKC

The committee is to send its report to Dean Office by May 15, 2018.

Action Required	**Action by**	**Responsibility of**
Implementation of the Decision	Committee	HOD EE BUKC
Statutory Documents affected:		

Item 1415: Addition/removal of course instructor approval for dropping a course (CS BUKC)

Sponsor: HOD CS BUKC Referral Authority: DBOS CS BUKC

Summary of the Case

In current form of dropping a course, there is a signature required by course instructor; however, the consent of the instructor is always ignored. The sponsor proposed to either make instructor's consent compulsory or remove this column from the form.

Discussion

HOD EE BUKC supported the agenda item while rest of the FBoS members agreed that no change is required as student can drop the course within two weeks which is automatic, dropping the course after two weeks and before midterm cost him/her 'W' grade and after midterms, grade is displayed on the transcript.

Decision 1415

FBoS agreed to maintain the status quo by majority vote. Point dropped.

Item 1416: Revision of annual appraisal form (CS BUKC)

Sponsor: HOD CS BUKC Referral Authority: DBOS CS BUKC

Summary of the Case

After practicing the existing appraisal form for two years, the following observations were presented to FBoS by the sponsor:

1. The form is same for all designations including lab engineers, however different designations and qualifications require different KPIs.
2. Semester implementation is based on daily activities that should be part of monthly assessment that must be reflected in appraisal collectively.

3. There is an ambiguity in many KPIs e.g. in research activities that is 20% for every faculty and the mentioned requirement is only national/international journal and the module is not categorized.
4. The reporting officer may be allowed to write confidential comments.
5. If this appraisal form is semester based, then separate forms should be introduced.

Discussion

The FBoS agreed upon most of the observations/recommendations, moreover, the FBoS chair constituted a committee to review and prepare KPIs and user manuals (helping material) to facilitate the faculty members & evaluators (HoDs in this case).

Decision 1416

The following committee is constituted to review the annual appraisal form:

i. Prof. Dr. Muhammad Zafar – EES, IC, Chair
ii. Dr. Humera Farooq – CS, IC
iii. Dr. Amina Jamil – CE, IC
iv. Dr. Atif Jafri – EE, IC
v. Mr. Farahan Sherazi – CS, LC

The committee is to forward its recommendations by May 15, 2018.

Action Required	**Action by**	**Responsibility of**
Implementation of the Decision	Committee	Dr. Muhammad Zafar
Statutory Documents affected: -		

Item 1417: PhD program in Geo-Physics –Launch Proposal (EES BUIC)

Sponsor: HOD EES BUIC Referral Authority: DBOS EES BUIC

Summary of the Case

Geophysics is a leading discipline of modeling the earth and is a major tool or technology for exploring the natural resources. The DBOS recommended starting PhD program in Geophysics from Fall 2018. The feasibility report, curricula/roadmap and list of available faculty for starting a PhD program are placed at Appendage 1417.

Discussion

The chair commented that the department had started two PhD programs during the last couple of years and strengthening of existing PhD programs should be desired as of now. In reply to the chair's argument the sponsor advocated his proposal by saying that geo-physics is in demand and many professionals from industry are now opting to pursue PhD in geo-physics. Moreover, one PhD faculty member is also applying for permanent position in the department.
The board then discussed the profile (experience) of the exiting PhD faculty with Geophysics specialization. The existing PhD FMs do not have post-doctoral three years of experience; FBoS suggested launching the program after strengthening the existing PhD programs and hiring of relevant experienced faculty.

Decision 1417

Launch of PhD program in Geo-Physics is pended for the time being.

Action Required	**Action by**	**Responsibility of**
Implementation of the Decision	HOD EES BUIC	HOD EES BUIC

Item 1418: Revision of Departmental Vision and program mission statements (SE BUIC)

Sponsor: HOD(SE)BUIC | Referral Authority: DBOS SE BUIC

Summary of the Case

As per PEC new regulation, "It should be ensured that the program mission and objectives are aligned with the vision of the institution. The program mission and objectives should be articulated and made known to everyone in the institution through institutional publications and websites". Revised program mission and objectives are placed at Appendage 1418.

Discussion

After detailed discussion and minor modifications, the agenda item was approved.

Decision 1418

Agenda item is forwarded to ACM for approval.

Item 1419: Revision in PhD roadmaps for CE, CS, EE, and SE

Sponsor: HOD SE BUIC | Referral Authority: Committee

Summary of the Case

The existing PhD curriculums of PhD programs in Engineering Sciences (CE, CS, EE, SE) were approved in 2012.The departments added elective course regularly in their respective domains. Dean - Engineering Sciences constituted the following committee to review the roadmaps of the PhD programs to align with the latest requirements:

- Dr. Awais Majeed, SE – BUIC – Chair
- Dr. Imran Siddiqi, CS – BUIC
- Dr. Muhammad Aamir, EE – BUIC
- Dr. Naveed Qaim Khani, EE – BUKC
- Dr. Osama Rehman, SE – BUKC
- Dr. Syed Safdar Ali Rizvi, CS – BUKC
- Dr. Asim Qureshi, CS – BUL C

The recommendations of the committee were deliberated in detail in the FBoS, PhD program structure and requirement are placed at Appendage 1419-1. The PhD road maps of SE, EE, CE and CS are placed at Appendage1419-PhD-SE, Appendage1419-PhD-EE, Appendage1419-PhD-CE and Appendage 1419-PhD-CS respectively.

Discussion

After detailed discussion, the recommendations of the committee were approved with minor changes.

Decision 1419

The FBoS recommended the item to ACM for approval.

Action Required	Action by	Responsibility of
Implementation of the Decision	HOD CE, EE & SE	Dean – ES
Statutory Documents affected: -		

Item 1420:	Revision of undergrad roadmaps for CS, SE and IT
Sponsor: Dean – ES	**Referral Authority: -**

Summary of the case:

National curriculum review committee (NCRC) of computing updated the curriculum for CS, IT and SE in February 2018 on the website, and the documentation is still awaited.

Discussion:
The chair emphasized the need to revise the BU curriculums so that the revisions are implemented w.e.f. next academic year.
The following committees were constituted to revise the curriculums inline with HEC guidelines:

BS-CS:

i. Dr. Faisal Bashir – HOD, CS, IC – Chair
ii. Dr. Asim Qureshi – AsP, CS, LC
iii. Dr. Bilal Hameed – Sr. AP, CS, KC
iv. Ms. Siama Jawad – Cluster Head, CS, IC
v. Mr. Tahir Iqbal – Cluster Head, CS, LC
vi. Mr. M. Tariq Siddique – Cluster Head, CS, KC

BS-IT:

i. Dr. Humera Farooq – HOD, CS, KC – Chair
ii. Mr. Farhan Sherazi – HOD, CS, LC
iii. Dr. Shagufta Henna – Sr. AP, CS, IC
iv. Dr. Asfand-e-Yar – Cluster Head (IT), IC
v. Dr. Abdul Hafeez – Cluster Head (IT), LC
vi. Ms. Aisha Danish – Cluster Head (IT), KC

BSE:

i. Dr. Awais Majeed - HoD, SE-IC
ii. Dr. Sohaib Ahmed - HoD, SE-KC
iii. Dr. Shahid Nazir Bhatti - AsP, SE-IC
iv. Dr. Osama Rehman - Sr. AP, SE-KC
v. Dr. Raja M. Suleman - Sr. AP, SE-IC

Decision 1420:
The committees are to present the revised roadmaps in the next FBoS.

Action Required	Action by	Responsibility of
Implementation of the Decision	Committees	Committees' heads

Item 1421:	Revision of BCE Roadmap (CE BUIC)
Sponsor: HOD CE BUIC	**Referral Authority: DBOS CE BUIC**

Summary of the case:

In the last PEC accreditation visit on 23rd May, 2017 at BUKC, the PEC team highlighted its concerns regarding the alignment of BCE roadmap with HEC. In the light of the need to update the roadmap along with the curriculum for the Computer Engineering (CE) program at Bahria University (both Islamabad and Karachi campuses), Dean Engineering Sciences formed a committee to execute this

task. Revised roadmap of BCE program attached at Appendage 1423-BCE-Roadmap may be considered for implementation from Fall 2018 intake.

Karachi Campus:

- Dr. Sohaib Ahmed
- Dr. Osama Rehman
- Engr. Ali Ahmed

Islamabad Campus:

- Dr. Shehzad Hassan
- Mr. Abu Bakar Yamin
- Mr. Ammar Ajmal
- Mrs. Bushra Sabir

Discussion:

The sponsor presented the revised roadmap. The board suggested few changes for course offering in different semesters which were incorporated.

Decision 1421:
The FBoS forwarded the item to ACM for approval.

Closing the Meeting

There being no further points, the Chair brought the meeting to close at about 17:15 hrs, thanking the participants for their wholehearted participation.

Prof. Dr. M. Najam-ul-Islam
Dean (ES), Head FBoS
March , 2018

Distribution:

BUHQ:	Rector, Pro-Rector, Registrar, DAA
BUIC:	DG BUIC, DIC, HOD(EE), HOD(SE), HOD(CE), HOD(CS), HOD(EES)
BUKC:	DG BUKC, DKC, HOD(EE), HOD(CSE), HOD(CS), HOD(EES)
BULC:	DLC, HOD(CS)

Appendages:

Appendage 1401

Microprocessors/ Microcontroller Based Systems	
Course Code:	CEN-321
Credit Hours:	3
Pre-requisite:	Digital Logic Design
Objectives:	The objective of this course is to give practical experience and knowledge to design microprocessor and microcontroller based systems. A portion of this course comprises on assembly language programming to understand the relation of software and hardware in microprocessor and microcontroller based systems. This course will focus on MCS-51 architecture; 8051 based system design and interface it with other devices. The students will explore built in and external peripherals with which interaction with external world is made possible. Various glue logic and peripheral control chips will be interfaced and programmed. This course eventually help student to understand how automated system are working in real word.
Course Learning Outcomes (CLOs):	**CLO 1:** (C2): The student should be able to **explain** the internal architecture, addressing modes, memory and I/O interface of 8086 microprocessor and interfacing with external memory. **CLO 2**(C2): The student should be able to **explain** internal architecture, addressing modes and functions of on chip microcontroller peripherals (input output ports, timers, serial port and interrupts). **CLO 3** (C3): The student should be able to **use** microcontroller/microprocessor by writing application in C/Assembly language. **CLO 4** (C4): The student should be able to **analyze** C/Assembly language code written to access different resources of 8051/8086.

Course Outline:	• Introduction to 8086 microprocessor and its architecture (Week 1 & 2) • 8086 family assembly language programming (Week 3 & 4) • Implementing Standard Program Structures in 8086 Assembly Language (Week 5 & 6) • Loops, Call instructions and Time Delay in 8086 using Assembly language (Week 7) • Memory Interfacing in 8086 microprocessor (Week 8) • Introduction to 8051 microcontroller and its architecture (Week 9 & 10) • 8051 assembly language programming and its addressing modes (Week 11) • Arithmetic Instructions, Time delay, Logic operations and I/O programming using Assembly Language and C in 8051 microcontroller (Week 12 & 13) • Timers in 8051 using Assembly and C (Week 14) • Serial Port Communication in 8051 using Assembly and C (Week 15) • Interrupts programming in 8051 using Assembly and C (Week 16)
Resources:	**Text Book: 1.** "The 8051 Microcontroller and Embedded Systems", M.A. Mazidi, J.G. Mazidi, Prentice Hall, 2004. **2.** The intel Microprocessors by Barry B. Brey 7th Edition
Tools	• **Software:** Keil u Vision, Proteus, MASM/TASM.

Mapping of CLO to PLOs

Contribution: Average: 1, Moderate: 2, Strong: 3

PLO	**CLO 1**	**CLO 2**	**CLO 3**	**CLO 4**
PLO 1: Engineering Knowledge	✔	✔	✔	✔
PLO 2: Problem analysis	✔	✔	✔	✔
PLO 3: Design			✔	
PLO 4: Investigation				
PLO 5: Tool usage			✔	
PLO 6: Engineer and society				
PLO 7: Environment				
PLO 8: Ethics				
PLO 9: Individual and team work				
PLO 10: Communications				
PLO 11: Project Management				
PLO 12: Lifelong learning				

Grading Rubric

Assessment Method	CLO 1	CLO 2	CLO 3	CLO 4
Final Exam	10	10	15	15
Mid Exam	5		5	10
Assignments			20	
Quizzes	2	2	3	3
Total (100)	17	12	43	28

Evaluation Criteria for achievement of CLOs

- Class average in CLO 1 should be 50% and above
- Class average in CLO 2 should be 50% and above
- Class average in CLO 3 should be 50% and above
- Class average in CLO 4 should be 50% and above

Microprocessors/ Microcontrollers Based Systems (Lab)	
Course Code:	CEL-441
Credit Hours:	1
Pre requisite:	Digital Logic Design
Objectives:	The objective of this lab course is to give practical experience and knowledge to design microprocessor and microcontroller based systems. A portion of this course comprises on assembly language programming to understand the relation of software and hardware in microprocessor and microcontroller based systems. This course will focus on MCS-51 architecture; 8051 based system design and interface it with other devices. The students will explore built in and external peripherals with which interaction with external world is made possible. Various glue logic and peripheral control chips will be interfaced and programmed in this laboratory. This course eventually help student to understand how automated system are working in real word.
Course Learning Outcomes (CLOs):	**CLO 1:** (P2): The student should be able to **execute** their software program for 8086 processor using TASM/MASM and Microprocessor trainer. **CLO 2**(P2): The students should be able to **execute** C and Assembly code intended to utilize resources of 8051such as Timers, Serial Communication, Interrupts and input output ports using Keil u Vision and proteus software and microcontroller Trainer. **CLO 3** (P4): **Integrate** a microcontroller with different I/O devices to provide embedded solution for real life engineering problem.

Course Outline:	• Introduction to Assembly language and TURBO Assemble(TASM). **(CLO 1)** • String definition, reversal and basic arithmetic operations in TURBO Assembler. **(CLO 1)** • Flow control instructions in TURBO Assembler. **(CLO 1)** • Parallel port operation and writing data to parallel port in TURBO Assembler. **(CLO 1)** • Introduction to MDA-EMS 196 Trainer. **(CLO 1)** • Keyboard Monitor Interfacing in MDA-EMS 196 Trainer. **(CLO 1)** • I/O programming in MDA-EMS 196 Trainer. **(CLO 1)** • Introduction of Keil u Vision, Proteus and 8051 Microcontroller and General Purpose I/O using Assembly and C Language. **(CLO 2)** • Interfacing Keypad and seven segment display with 89c51 Microcontroller. **(CLO 2)** • Generation of Square Waves with different Frequencies using Timers. **(CLO 2)** • Serial Communication using Microcontroller. **(CLO 2)** • Using Interrupts created by Timers and to observe the flow of program when Interrupt is Invoked. **(CLO 2)** • Interfacing LCD with Microcontroller. **(CLO 3)** • Interfacing Stepper Motor with Microcontroller. **(CLO 3)**
Resources:	**Text Book: 1.** "The 8051 Microcontroller and Embedded Systems", M.A. Mazidi, J.G. Mazidi, Prentice Hall, 2004. **2.** The intel Microprocessors by Barry B. Brey 7th Edition
Tools	• **Software:** Keil u Vision, Dataman, EZDL, Proteus, MASM, TASM . • **Hardware:** AT89C51 Microcontroller, Ems 196 Trainer. RIMS Trainer, 8086 Processor. RIMS Trainer

Mapping of CLO to PLOs

Contribution: Average: 1, Moderate: 2, Strong: 3

PLO	CLO 1	CLO 2	CLO 3	CLO 4
PLO 1: Engineering Knowledge	2	2		
PLO 2: Problem analysis	2	2		
PLO 3: Design			3	
PLO 4: Investigation				
PLO 5: Tool usage	3	3	3	
PLO 6: Engineer and society				
PLO 7: Environment				
PLO 8: Ethics				
PLO 9: Individual and team work			2	
PLO 10: Communications			2	
PLO 11: Project Management			2	
PLO 12: Lifelong learning				

Grading Rubric

Assessment Method	CLO 1	CLO 2	CLO 3	CLO 4
Final Viva (10)		10		
Mid Viva (10)	10			
Project (20)			20	
Lab Assessment (40)	20	20		
Lab Journal (20)	10	10		
Total (100)	40	40	20	

Evaluation Criteria for achievement of CLOs

- Class average in CLO 1 should be 50% and above
- Class average in CLO 2 should be 50% and above
- Class average in CLO 3 should be 60% and above

Lab Assessment Rubric

Category	Excellent 8	Good 6	Satisfactory 4	Needs improvement 2	Total (40)
Objectives and Results	Clearly describes the objectives of lab. Understands possible sources of errors and their effects. Suggests ways to minimize them.	Adequately describes the objectives, but cannot discuss possible sources of errors and their effects	Describes the objectives but misses some details. Cannot discuss possible sources of error or their effects	Cannot describe the objectives of the lab, or what was learnt, sources of errors and their effects	
Circuit implementation/ software coding	Circuit works perfectly. All wires are attached. / Code works perfectly	Circuit performs most the functions, gives output./ Code gives some errors	Circuit performs but output not exactly as expected. Some connections not done/ code gives some correct output	Circuit does not give any output. Most wires are not connected/ code not compiled/ many errors	
Trouble Shooting	Can clearly identify the problems and take steps to fix them. Uses an effective strategy to solve problems	Adequately identify the problems and steps taken to fix them. Uses an effective strategy but misses some details	Describe the problem but cannot suggest steps on how to solve them. Trouble shooting is not consistent.	Cannot describe the problem, and has no effective strategy on how to solve them.	
Measurements and	Detailed results are shown for	Adequate results are	Some missing observations.	Most results are missing. Only	

Observations	each step. 100% measurements are correct	shown. 80% measurements are correct	70% results are correct	30% measurements are correct
Conclusions	Thorough understanding of the concepts underlying the lab. Can apply it in real life situations	Good understanding of the concepts, however cannot apply them in real life situations	Limited understanding of the concepts. Cannot apply to real life situations and suggest any use of the knowledge	Shows incorrect understanding of the concept. Cannot find any usage of the knowledge. Cannot describe what was learnt.

Lab Journal / Report Assessment Rubric

Category	Excellent 5	Good 4	Satisfactory 3	Needs improvement 2	Total(20)
Neatness /Clarity	Neat presentation of material, no spelling or grammar errors, readable tables and labeled plots	Mostly neat, few grammar errors, few labels missing in graphs	Neat presentation, some wrong sentences, some grammar errors, majority of labels missing	Messy, incoherent, missing figures, tables and graphs, full of language errors	
Circuit design	Thorough explanation of design process. Clear understanding of circuit. No conceptual errors	Solid explanation of circuit blocks, with a few minor conceptual errors. Good use of circuit/ Code	Multiple conceptual errors. Some details missing or incorrect.	Demonstrated lack of understanding. Little or no explanation given for design	
Lab results	Key results displayed in concise and neat format (i.e. tables and graphs). All required results included	Most of required results are presented. Some superfluous values included in figures and not referenced in text.	Few of required results given. Presentation of results not organized.	Most results missing.	
Discussion	Complete and thorough description of results as they compare to theoretical outcomes. Thoughtful explanations of discrepancies with theory	Mostly complete comparison of results to theory. Some details overlooked. Good explanations of discrepancies	Some comparison of results to theory. Omission of some key points. Limited explanation of lab results.	Very little or incorrect discussion of results. Major conceptual errors.	

Background to the Case

- For OBE system implementation on BEE Program there is need to have clear vision at university and departmental level, mission at university and program level, program educational objectives, program learning outcomes, course learning outcomes and their mapping.

1. **University Vision**
   To become an internationally recognized university that contributes towards the development of nation through excellence in education and research.

2. **University Mission**
   To remain committed to the attainment of highest standards in teaching, learning and research, at par with the international standards.

- Department Vision, Program Mission and Program Educational Objective (and mapping) need to be designed or updated

Recommendations:

Following is the detail of each of afore-mentioned items.

1. **Department Vision**
   A commitment to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become the global leaders in their respective fields.
2. **Program Mission**
   The mission of BEE program is to produce ethically sound and technically competent engineers who can serve in the diverse fields of research, design & development, teaching, system installation, support and maintenance.

1. **Program Educational Objectives:**

PEO 1: Professional Employment

Find employment related to Electrical engineering in the fields of design, development, research, operations and maintenance, technical sales and marketing as well as explore entrepreneurship and find jobs in diverse areas like business, law, NGOs, media etc.

PEO 2:Technical competence

Demonstrate technical competence in the field of electrical engineering through finding solutions to complex problems, design new products, and use their analytic, engineering and problem solving skills to provide value to their industry.

PEO 3:Professional growth

Pursue their professional growth by taking up higher studies for advanced degrees, learn new technologies as they emerge, develop skills in the usage of new tools, undertake professional development courses and keep themselves current in their chosen specialization.

PEO 4:Social Engagement

Work in multicultural teams, provide leadership in their area; be sensitive to ethical, moral, environmental, gender and societal issues and leave an impact of their work on the society and the community.

Program Learning Outcomes

Following are the PLOs as approved by PEC.

PLO 1 (Engineering Knowledge): An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO 2 (Problem Analysis): An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO 3 (Design/Development of Solutions): An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO 4 (Investigation): An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO 5 (Modern Tool Usage): An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO 6 (The Engineer and Society): An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO 7 (Environment and Sustainability): An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PLO 8 (Professional Ethics): Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO 9 (Individual and Teamwork): An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

PLO 10 (Communication): An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PLO 11 (Project Management): An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

PLO 12 (Lifelong Learning): An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

1. **Mapping of PEOs on Departmental Vision and Program Mission to PEOs**

PEOs	Department Vision	Program Mission
PEO 1:	✓	✓
PEO 2:	✓	✓
PEO 3:	✓	✓
PEO 4:	✓	✓

2. **Mapping of PLOs on PEOs**

PLO	PEO1	PEO2	PEO3	PEO4
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: **Professional Ethics**				✓
PLO 9: **Individual and Teamwork**	✓		✓	✓
PLO 10: **Communication**	✓		✓	
PLO 11: **Project Management**	✓		✓	

PLO 12: **Lifelong Learning**			✓	

Background to the Case

- The OBE implementation has been started with reference to PEC guidelines since June 2017. The work on defining initial PEOs, PLOs and CLOs and correlating them with University Vision and Mission, Departmental vision and program mission is completed by each engineering department of BU (it will be presented by each department as separate agenda point). Now there is a need to establish a framework to implement CQI process which is an integral part of OBE system.
- The OBE model has three CQI cycles to update PEOs, PLOs and CLOs at periodic intervals which is shown in Figure 1.
- There is need to define the fine details of each CQI cycle.

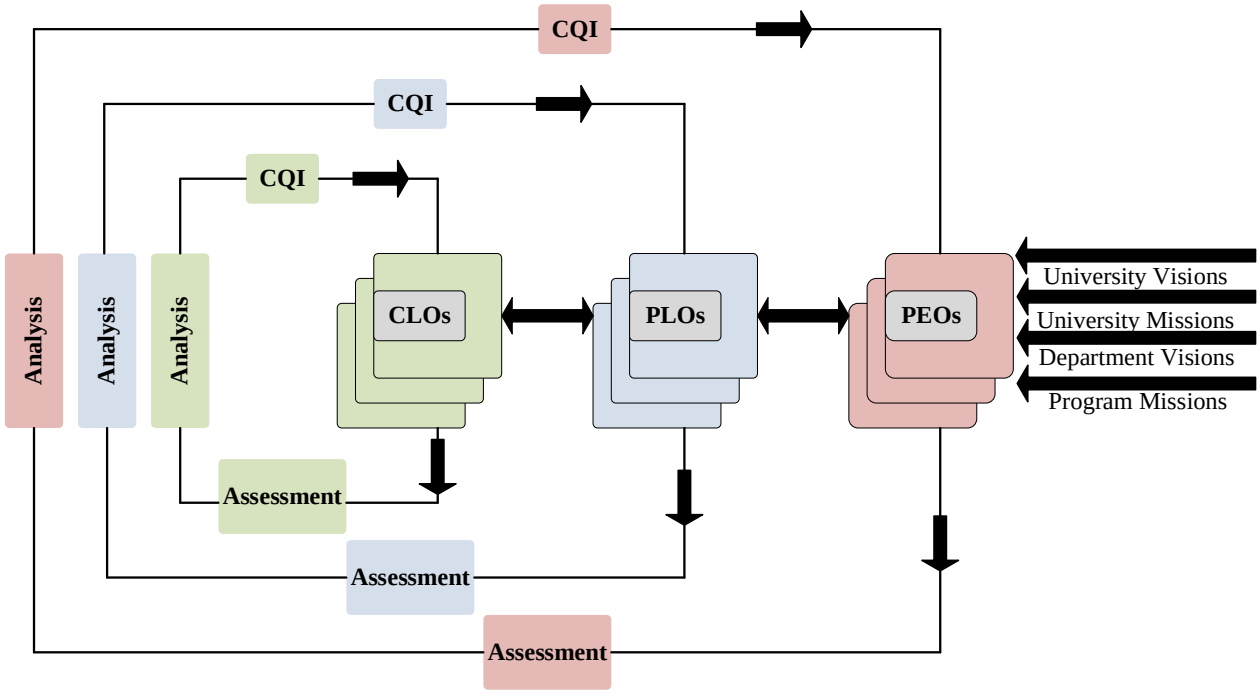


Figure 1: OBE Implementation Model for Engineering Departments

Financial Effect

Nil

Recommendations:

The overall CQI cycle applied on PEOs, PLOs and CLOs is described in Figure 1 and is detailed below:

1. **Process of Assessment of PEOs, PLOs and CLOs:**
   This will be a periodic process for assessment of each of PEOs, PLOs and CLOs.

1.1 PEO Assessment

The PEOs are assessed four years after graduation of a batch. In order to assess a PEO, information shall be collected using following sources:

- Employer Survey Forms
- Alumni Survey Forms
- CAC feedback

1.2 PLO Assessment

The PLOs are assessed every year during summer vacation using the following assessment tools:

- Internship Survey Forms
- CSP Feedback forms
- Exit Forms (Direct Method).

1.3 CLO Assessment

The CLOs are assessed at the end of the semester using the following assessment tools:

- Individual survey summary (Direct Method)
- Course Review Report by Instructor (Direct Method)
- CLOs based Result Assessments (made through exam, quiz, assignments and projects) (Direct Method)

2. Process of Analysis of Assessment results of PEOs, PLOs and CLOs:

Each engineering department will have its own OBE implementation team which will be responsible to analyze the assessment results of PEOs, PLOs and PEOs. The team will be composed of subject specialist FMs/ cluster heads and selected FMs. The internal working of the Departmental OBE Implementation Team is shown in Figure 2. This team will acquire/generate the required data (section 1), will perform the analysis and finally give its recommendations to update of CLOs, PLOs and PEOs, if required.

3. Process of update and establishing of PEOs, PLOs and CLOs:

The recommendations of the OBE implementation team will be discussed first of all at DBOS level and recommendations shall be forwarded to FBOS. Any change limited to change in CLOs shall be approved by the DBOS whereas changes in PLOs and PEOs shall be forwarded for approval to ACM after recommendation from DBOS and FBOS.

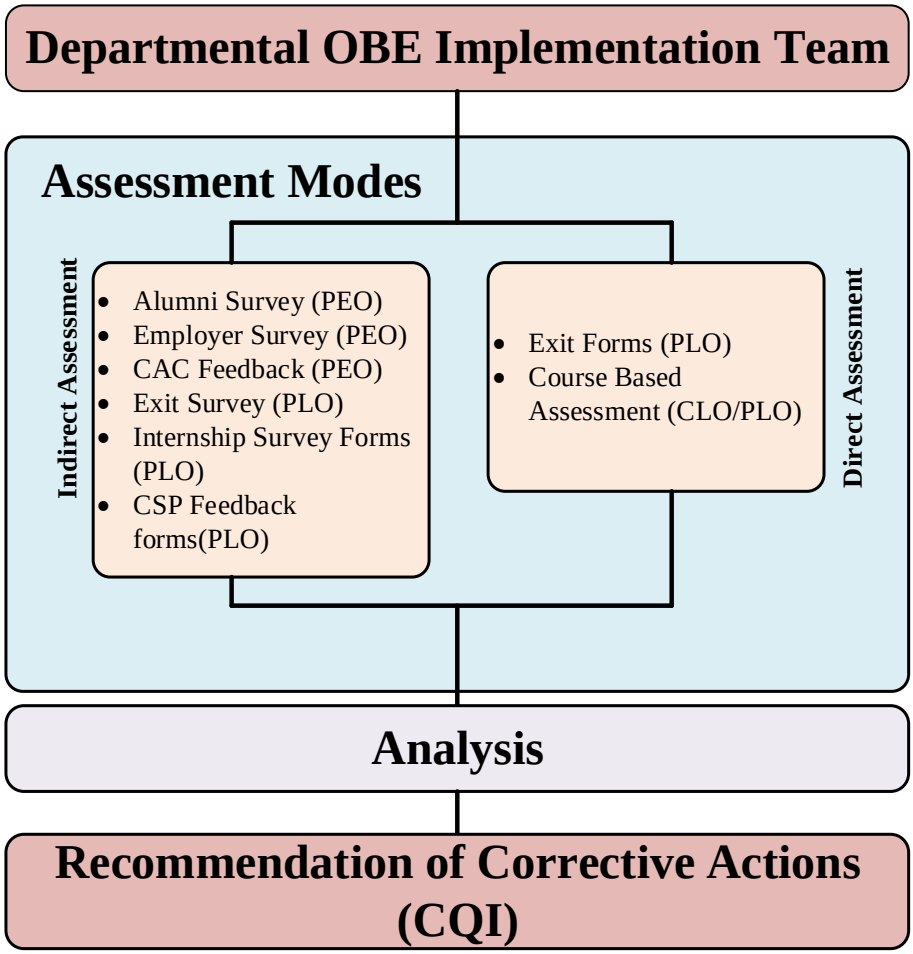


Figure 2: Functioning of Departmental OBE Implementation Team

4. Process of reviewing of PEOs, PLOs and CLOs:

Following are review process of PEOs, PLOs and CLOs. Figure No. 03 the CQI cycle foe the reviewing process of PEOs. PLOs and CLOs

4.1 Process of Reviewing PEOs

Process of reviewing of PEOs shall be based on KPIs set by each department. KPIs shall be set for the attainment of each PEOs based on the PEO assessment (section 1.1). KPIs shall recommended by department at DBOS and will be forwarded for further approval at FBOS.

4.2 Process of Reviewing PLOs

Process of reviewing of PLOs shall be based on data collected by PLO assessment (section 1.2). A PLO shall be revisited in case an overall satisfactory level of that PLO goes below 70%. Recommendation (or mapping) shall be discussed at DBOS and will be forwarded for further approval at FBOS.

4.3 Processing of Reviewing CLOs

Process of reviewing of CLOs shall be based on data collected by CLO assessment (section 1.3). A CLO shall be revisited in case an overall satisfactory level of that CLO goes below 60%. Recommendation (or mapping) shall be discussed by and reviewed by OBE Implementation team and will be forwarded for further approval at DBOS.

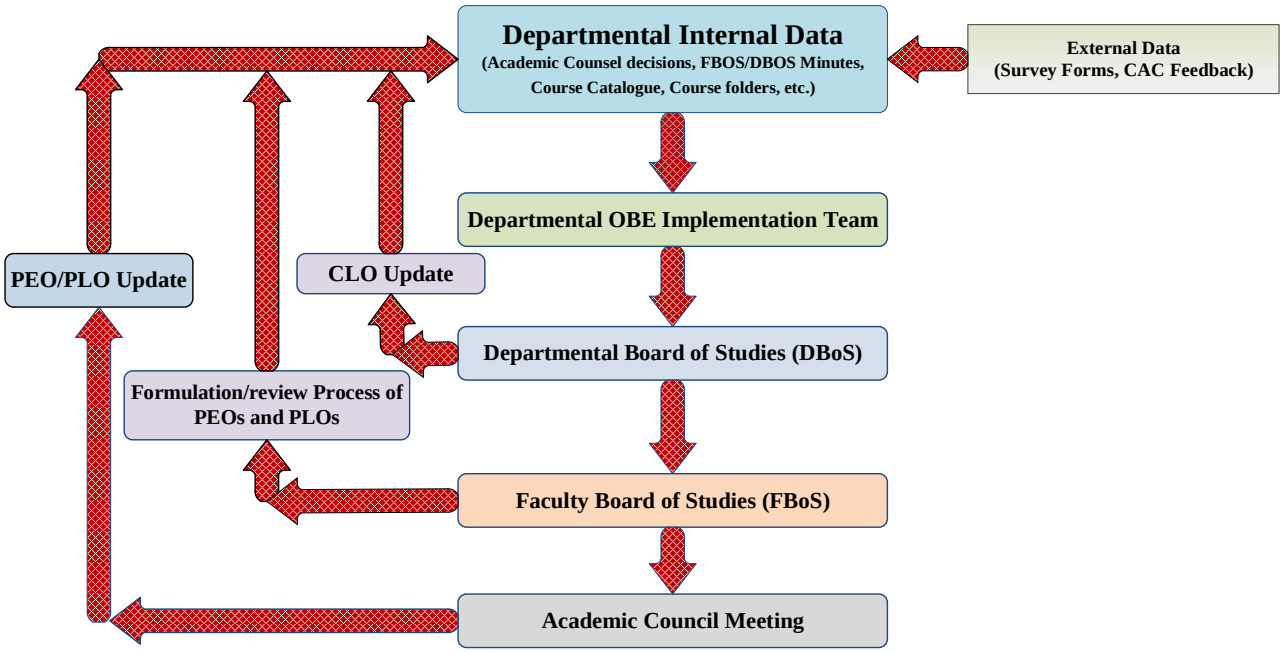


Figure 3: CQI Cycle for Reviewing Process of PEOs, PLOs and CLOs

5. **Clearing/Passing PLOs and CLOs in order to attain Graduate Status for Engineering Department**
6. A CLO shall be cleared if a student takes at least 50% marks in that CLO.
7. In order to clear a PLO 60% CLOs relate to that PLO should be cleared.
8. If failed to do so at the time graduation /(7th or 8th Semester end), Students shall be required to :
   - Attend workshop related to the said PLOs (as recommended by Dept. OBE Team)
   - A Comprehensive assignment in order to meet that PLOs (as recommended by Dept. OBE Team)

Appendage 1407

BAHRIA UNIVERSITY
DEPARTMENT OF SOFTWARE ENGINEERING

COURSE TITLE: SEMANTIC WEB
COURSE CODE: SEN-421

SN	EXPERIMENT TITLES
1	**Introduction to semantic web technologies**
2	**Structured web documents in XML**
3	**Resource Description Framework (RDF) and RDF Schema (RDFS)**
4	**Web Ontology Language (OWL)**
5	**Introduction to ontology development tool; Protégé**

6	**Properties and property restrictions**
7	**Build and analyze ontologies using Protégé**
8	**Logic reasoning for the semantic web**
9	**Description Logics and DL Queries**
10	**Querying using SPARQL**
11	**Advanced SPARQL queries**
12	**JENA & OWL API – Programming with ontology**
13	**Semantic web rule language (SWRL)**
14	**Developing Semantic web application**

BAHRIA UNIVERSITY
DEPARTMENT OF SOFTWARE ENGINEERING

COURSE TITLE: ADVANCED DATABASE MANAGEMENT SYSTEM
COURSE CODE: SEN-326

SN	EXPERIMENT TITLES
1	**Relational Set Operators**
2	**Data Extractions and Loading**
3	**Data Export and Import**
4	**SQL For summarized data in DWH**
5	**Establishing a DWH and Data Marts**
6	**Fragmentation, Allocation and Replication**
7	**Joining Tables and Sub-queries**
8	**Working with Packages**
9	**Objects, Member methods and methods over loading**
10	**Inheriting Object types in Oracle**
11	**Function Overriding in Object Oriented Databases**
12	**Abstraction in Objects**
13	**To learn different types of Methods in PL/SQL**
14	**Introduction to Data Mining tool WIKA**

BAHRIA UNIVERSITY
DEPARTMENT OF SOFTWARE ENGINEERING

COURSE TITLE: GAME APPLICATION DEVELOPMENT
COURSE CODE: SEN-328

SN	EXPERIMENT TITLES
1	Introduction to game design
2	Unity 3D
3	Working with 2D & 3D
4	UI Development
5	Start on Game Design
6	Game design Wrap-up
7	2D Game Design
8	3D Models and Debugging
9	Artificial Intelligence with Game development
10	Beyond Game Design: Programming
11	Affordance and user experience Design patterns
12	Creating non unity c#, Networking intro & JSON
13	Creating RESTful Interface
14	Connecting Games to Services Databases

BAHRIA UNIVERSITY
DEPARTMENT OF SOFTWARE ENGINEERING

COURSE TITLE: ROBOTICS
COURSE CODE: CEN-458

SN	EXPERIMENT TITLES
1	RASPBERRY PI: POWER UP , INSTALLATION & BASIC OPERATIONS
2	INTRODUCTION TO PYTHON 3
3	RASPBERRY PI NOIR CAMERA
4	ULTRASONIC SENSOR (HC-SR-04)
5	PIR SENSOR (HCSR – 501)

6	**SERVO MOTORS (MG – 945)**
7	**INTERFACING SERVO MOTORS AND SENSORS**
8	**FLUX, FORCE AND LOAD SENSORS**
9	**GSM MODULE (SIM 900A) & GPS MODULE (NEO-6M/7M)**
10	**HALL EFFECT SENSOR (ACS712) & RF MODULE (NRF24L01)**
11	**FINGER PRINT SENSOR & COLOR SENSOR (TCS-3200)**
12	**2WD & 4WD MOBILE ROBOT PLATFORM**
13	**RELAY CARD MOBILE (2,4 & 8-RELAY)**
14	**3 ACCESS DIGITAL ACCELEROMETER (ADXL-345) & 6 DOF SENSOR (GYRO+3 AXIS ACC) (MPU6050)**

BAHRIA UNIVERSITY
DEPARTMENT OF SOFTWARE ENGINEERING

COURSE TITLE: DATA MINING
COURSE CODE: CSC-452

SN	EXPERIMENT TITLES
1	**Introduction to WEKA & MATLAB for Data Mining**
2	**Essential MATLAB Programming for Data Mining**
3	**Data Preprocessing using MATLAB Statistical Functions**
4	**General Data Modeling & Visualization Functions**
5	**Implementing Naïve Bayes Classification Algorithm**
6	**Implementing K-Nearest Neighbor Algorithm**
7	**Implementing Decision Tree Algorithm**
8	**Implementing Multiple Regression for Predictive Analysis**
9	**Implementing Mining Frequent Patterns/Apriori Algorithm**
10	**Implementing Time Series Analysis**
11	**Implementing K-Mean Clustering Algorithm**
12	**Implementing Hierarchical Clustering Algorithm**
13	**Implementing Support Vector Machine Algorithm**
14	**Implementing Artificial Neural Networks for Classification**

Course Code	**DSC -501**
Course Title	**Data Science Foundations**
Credit Hours	**03 Credit Hours**
Degree Program	**MSCS**
Prerequisites	**None**
Textbook	1. A Simple Introduction to DATA SCIENCE: BOOK ONE by Lars Nielsen, Noreen Burlingame, 1st Edition, Publisher: New Street Communications, 2012. 2. A Simple Introduction to DATA SCIENCE: BOOK TWO by Lars Nielsen, John Eastman, 1st Edition, Publisher: New Street Communications, 2015
Reference Material	1. Analysis: An Introduction by Michael S. Lewis-Beck, 1st Edition, Publisher: SAGE University Papers, 2014. ISBN-13: 978-0803957725 2. Introduction to Data Science: A Python Approach to Concepts, Techniques and Applications by Laura Igual and Santi Seguí, Publisher: Springer. 2017 ISBN-13: 978-3319500164
Course Aims & Objectives	The objective is to cover key concepts adopted from statistics and machine learning, useful techniques for graph analysis and parallel programming, and the practical application of data science for such tasks as building recommender systems or performing sentiment analysis. The idea is to provide numerous practical case studies using real-world data to support understanding through hands-on experience of solving data science problems.
Course Description	Introduction to the infrastructure and architecture of data storage systems, with a focus on querying, exploring, understanding and transforming data features for statistical and machine learning applications. An in-depth study of basic classification, clustering and association mining techniques is also part of this course. Also describes techniques and tools for statistical analysis, machine learning, graph analysis, and parallel programming; review a range of applications of data science, including recommender systems and sentiment analysis of text data.

Course Code	**DSC – 704**
Course Title	**Distributed Data Engineering**
Credit Hours	**03 Credit Hours**
Degree Program	**MSCS**
Prerequisites	**None**
Textbook	1. Data Engineering Perfect by Brian Shive, Technics Publications, LLC, 2nd Edition, 2017. ISBN: 978-1935504603 2. Measurement and Data Analysis for Engineering and Science by Patrick F. Dunn (Author), CRC Press, 3rd Edition, 2016. ISBN: 978-1439825686
Reference Material	1. Data Visualization with Python and JavaScript: Scrape, Clean, Explore & Transform Your Data by Kyran Dale (Author), 2nd Edition, O'Reilly Media, 2017. ISBN: 978-1491920510 2. Machine Learning with Python: Understanding Machine Learning with Python in the World of Data Science by Robert Wilson, CreateSpace Independent Publishing, 1st Edition, 2016.

Course Objectives	The course is about well-designed conceptual and logical data models that the design has been built with flexibility and extensibility leading to high application agility and low maintenance costs. A detailed data flow diagrams means a concrete understanding of the business' value chain exists and is documented. The wish to understand how we think means excellent team dynamics while analyzing, designing, and building the application.
Course Description	This course will introduce students to working with distributed systems for efficiently collecting and analyzing large quantities of varied data. This is a survey-style course covering common data platforms and analysis patterns including Postgres (SQL), Hadoop (MapReduce), Spark, Kafka (logs), Lambda Architecture (streaming), and Cassandra (NoSQL).

Course Code	**DSC -705**
Course Title	**Deep Learning and Data Analysis**
Credit Hours	**03 Credit Hours**
Degree Program	**MSCS**
Prerequisites	**None**
Textbook	1. MACHINE LEARNING And DEEP LEARNING For Beginners by Ronald Davis (Author) Published by: Ronald Davis, 1st Edition 2017. 2. Machine Learning: Fundamental Algorithms for Supervised and Unsupervised Learning with Real-World Applications by Joshua Chapmann (Author, Publisher), 2nd Edition, 2017.
Reference Material	1. Machine Learning with R - Second Edition by Brett Lantz, Packt Publishing, Second Edition, 2015. ISBN: 978-1-78439-390-8 2. Machine Learning with Python: Understanding Machine Learning with Python in the World of Data Science by Robert Wilson, CreateSpace Independent Publishing, 1st Edition, 2016
Course Objectives	Machine learning is the next step in artificial intelligence and it is the reason many of the daily activities people enjoy are possible. Whether it's using your voice to control your smart device or being tagged in a picture on social media, machine learning makes it possible. It is machine learning that allows for the algorithms that let the various devices, programs, and machines to actually learn and adapt. This course is the next course of machine learning and data analysis and is about advanced machine learning topics.
Course Description	Advanced topics in machine learning with focus on optimization, probability theory, multi-model ensemble techniques, time series analysis, instrumental variable analysis and reinforcement learning. A data science solution implementation is also part of this course to develop implementation skills. On top of the based understanding of deep learning there are also plenty of scientific examples and datasets for you to practicing advanced machine learning problems

Course Title:	**Modeling and Control of Power Converters**	
Course Code:	**EEP 780**	
Credit Hours Theory:	3	
Credit Hours Lab (If Applicable):	N/A	
Pre-requisite	N/A	
Program/ Class	PhD-EE and MS-EE	
Semester	2	
Course Objectives:	Advanced modeling and control topics in power electronics, and power factor corrected supplies. Averaged switch modeling of converters, computer simulation, ac modeling of the discontinuous conduction mode, the current programmed mode, null double injection techniques in linear circuits, input filter design, harmonics in power systems, low-harmonic rectifiers, and introduction to digital control, programmable switching regulators, digital switch-mode controllers, and power electronic converter-on-a-chip development.	
Recommended Text Books:	• Erickson and Maksimovic, ***Fundamentals of Power Electronics***, 2nd edition, Springer	
Reference Books:	• Research paper	
General Instructions for students:	80%Attendance in all the classes is mandatory. Students will be required to carry out literature survey in their area of interest and write a review. They will also plan and coordinate all the activities involved in organizing a scientific conference and will deliver presentations on assigned topics. **Marks Distribution:** Quizzes: 10% Assignments/Projects/Presentations: 10%, 10% Midterm Examination: 20% Final Examination: 50%	
Sixteen weeks plan:	Week-1:	Modeling and control introduction for power converters and systems. • Introduction to power electronics systems • Review of power converters basic
	Week-2:	Dynamics of power converters Basics of converters dynamics
	Week-3:	AC Equivalent Circuit Models • Basic AC Modelling Approach • State Space Averaging • The Canonical Circuit Models
	Week-4:	Analysis of Converter Transfer Functions
	Week-5:	Controller Design • Regulator Design • Stability analysis of the Converters
	Week-6:	
	Week-7:	Frequency modulation control techniques
	Week-8:	AC and DC Equivalent Circuit Modelling of the Discontinuous Conduction Mode
	Week-9:	Introduction to Digital Control of Switching Converters • Supplementary notes posted on the web site • Digital realization of the basic control loop • Discrete-time converter model • Examples of discrete-time compensator design
	Week-10:	Input Filter Design and its effect on Converters Transfer functions
	Week-11:	Modern Rectifiers • Power and Harmonics in Non-sinusoidal Systems • Pulse-Width Modulated Rectifiers • Modeling, analysis, and control of low-harmonic rectifiers • Boost, flyback, and other topologies for controlling the input current waveform of an ac-dc rectifier

	Week-12:	Multi-loop control system analysis and design All-state feedback/pole placement technique Modern Rectifiers • Average-current, peak-current-mode, critical conduction mode, and nonlinear carrier control techniques • Determination of RMS currents, and comparison of performances of popular topologies • System considerations. Modeling losses. Simulation
	Power Cable Engineering	
Course Code:	**EEP781**	
	Week-13:	Sinusoidal analysis of resonant converters • Series resonant converter • Parallel resonant converter Exact characteristics of the series and parallel resonant converters
	Week-14:	Soft switching techniques for Resonant Converters Zero current switching Zero voltage switching The zero voltage transition converter Load-dependent properties of resonant converters
	Week-15:	Real cases design. • Buck converter with voltage mode control loop. • Boost converter with average current mode control loop. • Adapter for battery charge in mobile phone applications. • Multiphase converter for high performance microprocessors.
	Week-16:	Real cases design. • Power distribution system for telecommunication application. • Modelling and control of Single-Phase Voltage Source Inverters. • Three-phase inverter with d-q control for renewable energy applications.
Updated By:	Dr. Muhammad Aamir	

Credit Hours Theory:	3	
Credit Hours Lab (If Applicable):	N/A	
Pre-requisite	N/A	
Program/ Class	PhD-EE and MS-EE	
Semester	3	
Course Objectives:	Introduction to power cables, overhead lines vs cables, cable benefits and problems, cable types, cable applications, cable components, insulation of cables, cable design, production processes, quality management for cable production, cable accessories, worldwide cable projects, cable applications in high power transmission systems.	
Recommended Text Books:	• Electric Power Cable Engineering by William Thue	
Reference Books:	• Electric Cables Handbook by Malestorm	
General Instructions for students:	80%Attendance in all the classes is mandatory. Students will be required to carry out literature survey in their area of interest and write a review. They will also plan and coordinate all the activities involved in organizing a scientific conference and will deliver presentations on assigned topics. **Marks Distribution:** Quizzes: 10% Assignments/Projects/Presentations: 10%, 10% Midterm Examination: 20% Final Examination: 50%	
Sixteen weeks plan:	Week-1:	Introduction to power cables, why cables instead of lines, cable installations over the years
	Week-2:	Nexans power cable company, infrastructure introduction
	Week-3:	Components of a power cable, conductor types, insulation material etc.
	Week-4:	Design considerations in cable engineering
	Week-5:	Insulation selection based on applications, mass-impregnated paper insulation, oil-impregnated paper insulation, plastic insulation
	Week-6:	Cable production, solid vs stranded conductor production, paper insulation, insulation testing, HV tests
	Week-8:	Stranded conductor production, introduction to continuous rotary extrusion process, super positioned linear and rotary motion process, stranding schemes,
	Week-9:	Introduction to quality systems in cable industry, total quality improvement, raw material testing, in-process inspection and testing, partial discharge testing, UV testing, on-site testing.
	Week-10:	Cable accessories, joints, terminators, heat-shrink process, cold-shrink process, screwing and welding, cadweld process, field control for MV and HV cables
	Week-11:	Global projects involving power cables, submarine cable projects, HVDC cable projects
	Week-12:	Cables in HVDC systems, design and operational aspects.
	Week-13:	Cables in HVAC systems, universal acceptance, design and operational aspects
	Week-14:	Cables in low voltage and medium voltage networks, techno-economic analysis
	Week-15:	Simulation studies with cable vs lines-1
	Week-16:	Simulation studies with cable vs lines-2
Updated By:	Dr. Asad Waqar	

Course Title:	**Distributed Generation & Microgrids**
Course Code:	**EEP782**
Credit Hours Theory:	3
Pre-requisite	N/A
Program/ Class	PhD-EE and MS-EE
Semester	3
Course Objectives:	Introduction to Distributed Generation, Definition and types of Distributed Generation technologies with DG capacities, Applications of Distributed Generation (DG), Impact of Distributed Generation on Power System Grids, Voltage Regulation, Losses, Harmonics, and Short Circuit Levels of the Network; Influence of DG, Influence of DG in service and product quality; Location of DG in the Distribution Networks and its Topology, Distributed Power System Reliability, Islanding of a Power Networks, Microgrids.
Recommended Text Books:	• Electric Power Distribution Reliability, Second Edition by Richard E. Brown • Integration of Distributed Generation in the Power System by Math H. Bollen, Fainan Hassan
Reference Books:	• A New Multilevel Conversion Structure for Grid-Connected Photo Voltaic Applications, G. Grandi, C. Rossi, D. Ostojic, and D. Casadei. • A Review of the State of the Art of Power Electronics for Wind Turbines, Z. Chen, J.M. Guerrero, and F. Blaabjerg. • A Space Vector Modulated STATCOM Based on a Three-Level Neutral Point Clamped Converter, M. Saeedifard, H. Nikkhajoei, and R. Iravani, IEEE Trans. on Power Delivery. • A Space Vector Modulation Strategy for a Back-to-Back Five-Level HVDC Converter System,, M. Saeedifard, R. Iravani, and J. Pou. • A Three-Level Converter Based Micro-Turbine Distributed Generation System, Nikkhajoei, M. Saeedifard, and R. Iravani. • Analysis and Control of DC-capacitor Voltage Drift Phenomenon of a Passive Front-End Five-Level Converter, M. Saeedifard, R. Iravani, and J. Pou. • Control Algorithm of Fuel Cell and Batteries for Distributed Generation System, P. Thounthong and B. Davat. • HVDC connection of offshore wind farms to the transmission system, P. Bresesti, W. Kling, R. Hendriks, and R. Vailati. • Large offshore DFIG-based wind farm with line-commutated HVDC connection to the main grid: Engineering studies, S. Bozhko, G. Asher, L. Risheng, J. Clare, and Y. Liangzhong. • Low Switching Frequency Space Vector Modulators For High Power Multi-Modular Converters, M. Saeedifard, A. Bakhshai, and G. Joos, IEEE Trans. on Power Electronics, 2005. • Power management strategies for a microgrid with multiple distributed generation units, F. Katiraei and M. Iravani. • Several journal/conference papers will be used as the main text for the course. • Stability of photovoltaic and wind turbine grid-connected inverters for a large set of grid impedance values, M. Liserre, R. Teodorescu, and F. Blaabjerg. • VSC-based HVDC power transmission systems: An overview., N. Flourentzou, V. Agelidis, and G. Demetriades. • Wind and Solar Power Systems, Design, Analysis, and Operation, M.R. Patel, Taylor & Francis, 2006.
General Instructions for students:	80%Attendance in all the classes is mandatory. Students will be required to carry out literature survey in their area of interest and write a review. They will also plan and coordinate all the activities involved in organizing a scientific conference and will deliver presentations on assigned topics. **Marks Distribution:** Quizzes: 10% Assignments/Projects/Presentations: 10%, 10% Midterm Examination: 20% Final Examination: 50%
Sixteen weeks plan:	Week-1: Introduction to Distributed Generation, DG types, integration levels Week-2: Solar energy systems, site selection and capacity calculations, issues associated and remedies, control design

	Week-3:	Wind energy systems, site selection and capacity calculations, issues associated and remedies, control design
	Week-4:	Micro turbines and biomass generation systems
	Week-5:	Solar and Wind Energy Generation PV Converter Technologies
	Week-6:	Maximum Power Point Tracking Techniques Grid Requirements for PV Converters
	Week-8:	Wind Energy Overview of Electrical Systems for Wind Energy Conversion Challenges in Grid Integration of Wind Farms
	Week-9:	Islanded operation of distributed generation, challenges and way outs.
	Week-10:	Role of Storage in distributed generation
	Week-11:	Economics of distributed generation
	Week-12:	Transmission Challenges DC Transmission vs. AC Transmission HVDC Transmission System for Grid Integration of Renewable Energy Resources Line-Commutated Converter (LCC)-Based HVDC System Control of LLC-Based HVDC System Fault Scenarios
	Week-13:	Misoperation of the LCC-Based HVDC System Voltage-Sourced Converter (VSC)-Based HVDC System High-Power Converter Topologies and Modulation Strategies Control of VSC-Based HVDC System Tapping the HVDC Line and Multi-Terminal Configurations
	Week-14:	Introduction to microgrids, DGs in microgrids, microgrid benchmark models
	Week-15:	Operation of microgrids in grid-connected and islanded modes, frequency and voltage regulation of microgrids
	Week-16:	Energy and power management strategies for microgrids
Updated By:	Dr. Asad Waqar	

Advanced Digital Control systems	
Course Code:	EEN731
Credit Hours:	3
Pre-requisite:	• Linear Control System • Digital Control system
Objectives:	On the completion of the course, the student shall be able to Represent discrete time systems under the form of z-domain transfer functions and state-space models. 1. Analyze stability, transient response and steady state behavior of linear discrete-time systems, analytically and numerically using tools such as MATLAB and Simulink. 2. Design digital control systems using transform techniques and state-space methods. 3. Describe and test controllability and observability of linear systems. 4. Design full- and reduced-order observers for discrete-time linear systems.
Course Outline:	• Introduction to advanced digital control • Discrete time systems • Modeling of digital controls systems • Stability of digital control systems • Digital control systems design • State space representation of digital control systems

	• Properties of discrete state-space models • State feedback digital control • Introduction to optimal digital control • Introduction to nonlinear digital control • Practical issues.
Resources:	1. M.S. Santina, A.R. Stubberud, G.H Hostetter, Digital Control System Design, 2nd Edition, Oxford University Press, 1994. 2. Fadali and Visioli, Digital Control Engineering, Academic Press (AP). 3. Dogan Ibrahim, Microcontroller Based Applied Digital Control, Wiley; 1st edition, 2006. 4. Joseph L. Hellerstein, Yixin Diao, Sujay Parekh, Dawn M. Tilbury, Feedback Control of Computing Systems, Wiley-IEEE Press; 1st edition, 2004

Course Title:	**LTE Mobile Communication Systems**
Course Code:	EET771
Credit Hours Theory:	3
Credit Hours Lab (If Applicable):	1
Pre-requisite	Advance Digital Communication System
Program/ Class	PhD (EE) and MS (EE)
Semester	2
Instructor Name with Qualification:	Dr. Saleem Aslam, PhD (Information and Communication)
Course Objectives:	The objective of this course is to design a LTE physical layer system. LTE system is one of the most widely investigated wireless systems in practice and is a conglomerate of lots of the emerging advanced signal processing and transmission technologies. Throughout this advanced course, students will learn the fundamentals of OFDMA-based mobile cellular communication systems as well as the details on how those techniques are used in practical systems.
Learning Outcomes:	After completing this course, students will be able to learn about: • Introduction to mobile communication systems • Wireless channel propagation • OFDMA and SC-FDMA systems • Reference signals and channel estimation • MIMO communications • Multi-user communications • Wireless communication standards with the related technologies
Contents (Catalog Description):	This course covers the theoretical details of 3GPP LTE wireless mobile Communication system including physical layer technology and LTE networking architecture. It also covers the future of LTE-A and 5G communication systems
Recommended Text Books:	"LTE - The UMTS Long Term Evolution: From Theory to Practice" by Stefania Sesia, et. al. Wiley
Reference Books:	"LTE/LTE-Advanced for Mobile Broadband" by Erik Dahlman, et. al. Elsevier Academic Press
Computer Usage	• Matlab /Simulink
General Instructions for students:	80%Attendance in all the classes is mandatory. Students will be required to carry out literature survey in their area of interest and write a review. They will also plan and coordinate all the activities involved in organizing a scientific conference and will deliver presentations on assigned topics. Marks Distribution: Quizzes: 10% Assignments/Projects: 10%, 10% Midterm Examination: 20% Final Examination: 40%

Sixteen weeks plan:		
	Week-1:	Introduction to Wireless Communication Systems
	Week-2:	Introduction to wireless mobile systems
	Week-3:	Introduction to 3GPP LTE system
	Week-4:	OFDMA
	Week-5:	Downlink physical layers
	Week-6:	Reference signals and channel estimation
	Week-7:	Control and data planes
	Week-8:	SC-FDMA and uplink physical layer
	Week-9:	Channel coding
	Week-10:	Multiple antenna techniques
	Week-11:	Multiuser scheduling
	Week-12:	Network architecture
	Week-13:	LTE advanced system

	Week-14:	Interference coordination
	Week-15:	Future of LTE-A and 5G Systems
	Week-16:	Advance Topics
Updated By:	Dr. Saleem Aslam	

	Advance Wireless Systems Design	
Course Code:	EET773	
Credit Hours Theory:	3	
Credit Hours Lab (If Applicable):	1	
Pre-requisite	Advance Digital Communication System	
Program/ Class	PhD	
Semester	2	
Instructor Name with Qualification:	Dr. Saleem Aslam, PhD (Information and Communication)	
Course Objectives:	This is an advanced graduate course in the area of wireless (or digital) communications. The main objective of the course is to equip students with fundamental principles and analytical techniques required to design digital communication systems. The focus will be on multiuser communications and advanced techniques for high performance from both theoretic and practical viewpoints.	
Learning Outcomes:	After completing this course, students will be able to learn about: • Introduction to wireless communications • Communication System design • Performance analysis of communication systems • Multiple access techniques • Orthogonal frequency division multiplex systems • Multi-user communication systems • Wireless communication standards	
Contents (Catalog Description):	Introduction to modern wireless communication systems and its basic concept are covered, Along with effect of multiuser environment is studied. Detailed analysis of OFDM and SC-FDMA is covered And performance evaluation in terms of advance wireless communication system is also covered	
Recommended Text Books:	• "Wireless Communications" by Andrea Goldsmith Cambridge University Press • "Fundamentals of Wireless Communication" by D. Tse and P. Viswanath, Cambridge, 2011	
Reference Books:	• Digital Communications over Fading Channels, A Unified Approach to Performance Analysis" by M. K. Simon and M. S. Alouini, Wiley, 2012 • "Digital Communications" by J. G. Proakis, McGraw-Hill, 2008	
Computer Usage	• Matlab /Simulink	
General Instructions for students:	80%Attendance in all the classes is mandatory. Students will be required to carry out literature survey in their area of interest and write a review. They will also plan and coordinate all the activities involved in organizing a scientific conference and will deliver presentations on assigned topics. **Marks Distribution:** Quizzes: 10% Assignments/Projects/Critical review: 10%, 10%,10% Midterm Examination: 20% Final Examination: 40%	
Sixteen weeks plan:	Week-1:	Introduction to Wireless Communication Systems
	Week-2:	Basics of Wireless Communication Systems

	Week-3:	Introduction to MIMO systems
	Week-4:	3D/Massive MIMO building blocks
	Week-5:	Performance evaluation metrics of WCS
	Week-6:	Performance evaluation of advance level WCS
	Week-7:	Adaptive Modulation
	Week-8:	Multiple Access techniques
	Week-9:	OFDMA
	Week-10:	SC-|FDMA
	Week-11:	Multi-user Channel
	Week-12:	Multi-user Diversity
	Week-13:	Multi-user MIMO
	Week-14:	Effect on WCS in an Multi-user environment
	Week-15:	Wireless Sensor Networks
	Week-16:	Relevant Advance Topics
Updated By:	Dr. Saleem Aslam	

Course Title: **Deep Learning for Pattern Recognition**
Course Code: **CSC-785**
Pre-Requisite: **CSC – 719 (Machine Learning) / CSC – 753 (Pattern Recognition)**

Objectives:
The objective of this course is to acquaint the students with the state-of-the-art deep learning techniques to solve different learning problems. Students will learn to design as well as implement deep neural network architectures (through hands-on tasks) to solve various recognition problems.
Contents:
Introduction to neural networks, activation functions and back-propagation; Convolutional Neural Networks: History, Convolution, Pooling, CNNs for classification, Deep learning Software, CNN Architectures: AlexNet, VggNet, GoogLeNet, ResNet, Recurrent Neural Networks: Long-Short Term Memory models and variants, Language modeling and image captioning, Unsupervised learning: Restricted Boltzmann Machines and Auto-encoders; Capsule Networks, Case Studies.

Addition of New Courses (Electives) in MS Software Engineering Roadmap

Course Title: Empirical Software Engineering
Course Code: SEN 757
Credit Hours: (03)
Course Description:
With the passage of time, there has been ever increasing focus of Software Engineering community on evidence based and empirical studies in the domain. Eventually it will lead to experimental Software Engineering with more focused and scientific research finding. Empirical methods such as controlled experiments, case studies, surveys and post-mortem analyses are helpful to help us evaluate and validate the research results. This course will enable the scholars to learn about various types of empirical research techniques including experiments, case study, Post-mortem analysis in the context of Software Engineering domain. Upon completion of this course, the students will be able to:

- Understand the need, concepts and applications of various empirical methods
- Understand, analyze and critically evaluate already published empirical studies in the domain
- Apply, design and execute a particular research study based on an appropriate empirical research method.

Recommended Books/Reading Materials:

1. Ruchika Malhotra, "Empirical Research in Software Engineering, Concepts, Analysis and Applications", CRC Press, 2016.
2. Per Runeson, Martin Host, Austen Rainer, Bjorn Regnell, “Case Study Research In Software Engineering; Guidelines And Examples”, John Wiley & Sons, 2012.

Course Title: Intelligent Tutoring Systems
Course Code: SEN 750
Credit Hours: (03)
Course Description:
This course addresses the use of Artificial Intelligence to create computer-based Intelligent Tutoring Systems (ITSs). Students will learn data-driven and theoretical methods for creating ITSs. ITSs have been demonstrated to dramatically enhance student learning in many domains, including, to name a few, mathematics, computer science, medicine, biology and engineering. In addition to discussion and readings about methods and models of problem solving, learning, and tutor design, the course will have a "learning by doing" component.
Upon completion of this course, the students will be able to:

- Understand key ideas in the area of Artificial Intelligence in Education.
- Understand the basics of psychology of learning.
- Explain the functionality of ITSs.
- Critically assess approaches to student modelling in ITSs.
- Design constraints and production rules for use in ITSs.
- Design and develop small-scale constraint-based tutors
- Evaluate ITSs
- Understand and assess current research topics in the area of Artificial Intelligence in Education

Recommended Books/Reading Materials:

1. Building Intelligent Interactive Tutors: Student-centered strategies for revolutionizing e-learning by Beverly Park Woolf; published by Morgan Kaufmann. (2009)
2. Relevant research papers and case studies

Appendage 1411

Updated CE Department framework for OBE implementation.

1. **Department Vision**

   The Computer Engineering Department is committed to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become global leaders in their respective fields.

2. **Program Mission**

   The mission of Bachelor of Computer Engineering program is to educate engineers by expanding knowledge and developing new methods/capabilities for solving complex technological problems through innovation in various domains of Computer Engineering.

3. **Program Educational Objectives:**
   Graduates of Computer Engineering Program are expected to achieve following Program Educational Objectives for BCE program.

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.

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 capabilities for their personal growth and the betterment of society.

4. Program Learning Outcomes:

The Computer Engineering program prepares students to attain the program educational objectives by ensuring that students demonstrate achievement of the following graduate attributes.

PLO-1 Engineering Knowledge: An ability to apply knowledge of mathematics, computer engineering fundamentals and computer engineering specialization to the solution of complex engineering problems.

PLO-2 Problem Analysis: An ability to identify, formulate, research literature and analyze complex computer engineering problems reaching substantiated conclusions using engineering and natural sciences principles.

PLO-3 Design/Development of Solutions: An ability to design solutions for complex computer engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health & safety, cultural, societal, and environmental considerations.

PLO-4 Investigation: An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO-5 Modern Tool Usage: An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO-6 The Engineer and Society: An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO-7 Environment and Sustainability: An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PLO-8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO-9 Individual and Team Work: An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

PLO-10 Communication: Ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PLO-11 Project Management: Ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

PLO-12 Lifelong Learning: Ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

PEOs and PLOs Mapping

		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 1412

Subject: OBE Implementation

1. Background to the Case

CQI strategies to optimize the quality of CE program were formulated and then discussed in DBOS.

CQI process for PEOs:

PEOs are designed to address the requirements and expectations of the various stakeholders. The PEOs describe the expected accomplishments of graduates after four (4) years graduation. The achievement of PEOs ensures the successful implementation of CLOs and PLOS, for this purpose CQI committee of CE department has tailored a comprehensive CQI process with various activities/ actions which are depicted in Figure 1.

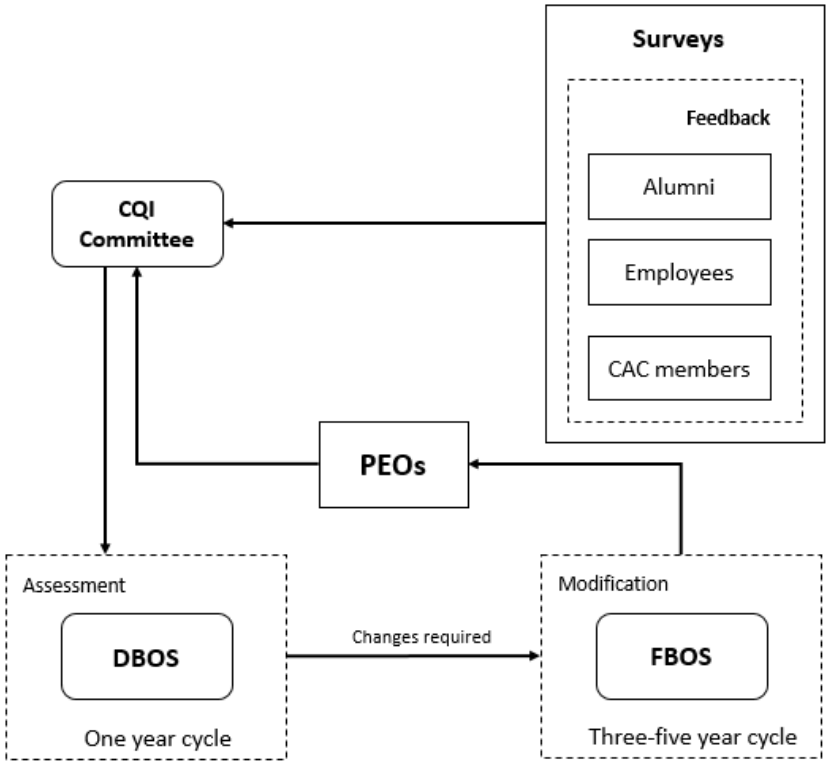


Figure 1: CQI process for PEOs attainment

The flowchart describes the various stake holders that participate in the decision making and the feedback loops that inform the planning, execution and review process. The process of CQI is met through three distinct modules as shown in the flowchart. Firstly, feedback is collected from alumni, employees and CAC members through survey forms (Attached). The CQI committee, responsible for revision and improvement of PEOs and PLOs, analyzes the feedback results to see whether the alumni and employees requirements are being met and need revision. In case of revision, PEOs are revised in DBOS and are further verified by CQI committee and are finally approved by FBOS and ACM.

CQI process for PLOs:

PLOs (Program Learning Outcomes) describe what students are expected to know and are able to do by the time of graduation. There are 12 PLOs defined by PEC and the same are being implemented by the department. The attainability criteria for PLOs is 50% and in case of failure, students should take extra course mapped on the respective PLO to improve the outcomes.

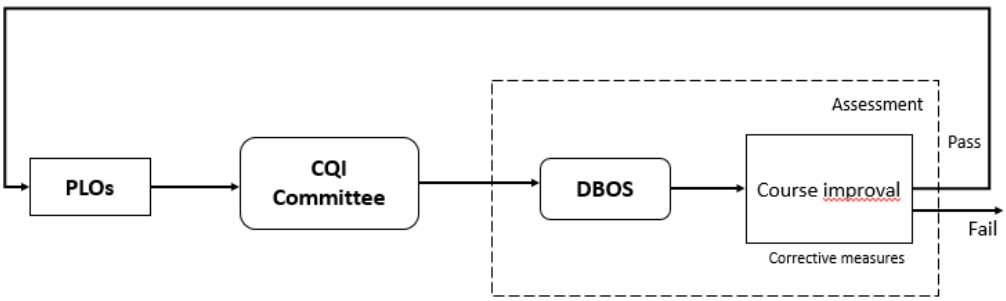


Figure 2: PLO Failure/Recommendation

CQI process for CLOs:

CLOs (Course Learning Outcomes) describe what student is expected to learn in any course, thereby, different CLOs are defined against all courses using Bloom's Taxonomy. To attain CLO in any lab/course a student must score 40% in the respective CLO. If any student fails to achieve any CLO then he/she will be assigned with extra task mapped on the respective CLO in order to attain the respective CLO. However, if 50% of the class in not able to attain any CLO then a detailed analysis report must be generated to revise the CLO. The CQI process for the attainment of CLOs is illustrated in figure 3.

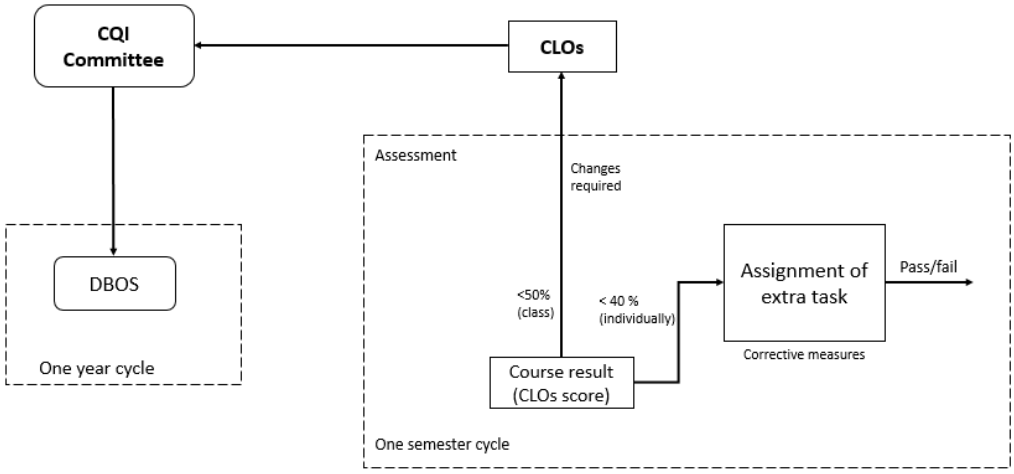


Figure 2: CQI process CLOs attainment

BAHRIA UNIVERISTY, ISLAMABAD CAMPUS
Department of Computer Engineering

PEOs FEEDBACK FORM FOR ALUMNI

NAME: BATCH:

ARE YOU CURRENTLY EMPLOYED: YES N☐ ☐

DESIGNATION: ORGANIZATION:

PHONE NO. E-MAIL:

University VISION Statement

To become an internationally recognized university that contributes towards the development of nation through excellence in education and research.

University MISSION Statement

To remain committed to the attainment of highest standards in teaching, learning and research, at par with the international standards.

Department VISION Statement

Commitment to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become global leaders in their respective fields.

Department MISSION Statement

The mission of Computer Engineering program is to educate engineers by expanding knowledge and developing new methods/capabilities for solving complex technological problems through innovation in various domains of Computer Engineering e.g. digital design, networking and signal processing.

Program Educational Objectives (PEOs)

1. Attain an ability to identify and solve challenging problems in their professions applying theory, principles and modern tools learnt during degree program
2. Practice their professions conforming to public health and safety, high moral and ethical values
3. Demonstrate effective communication as an individuals or team players with strong managerial and entrepreneurial skills
4. Engage in life-long learning to continually polish their professional capabilities for their personal growth and the betterment of society

Dear Alumni Member,

We are glad that you have spent your four valuable years of Bachelor in Computer Engineering at Computer Engineering Department, Bahria University. You will be pleased to know that your institute has, in a short period of time, grown to be one of the leading and sought-after institutes. We would like to place on record that your co-operation and support has contributed in no small measure for this achievement.

To maintain and enhance higher teaching and research practices at Bahria University, the department of Computer Engineering has enlisted a few *Program Educational Objectives(PEOs)* inline to the Washington Accord's consortium.

We shall very much appreciate and be thankful if you can spare some of your valuable time to fill up this feedback form and give us your valuable suggestions for further improvement of this process.

S. No.	QUESTIONS	Rating			
		1	**2**	**3**	**4**
		Strongly Agreed	*Agreed*	*Neutral*	*Disagreed*
1	Are you satisfied with the declared Program Educational Objectives (PEOs) of the Computer Engineering Department?				
2	According to your experience whether the current BCE program is compliant to the above mentioned PEOs?				
3	Whether the department is moving in the right direction towards the attainment of the said PEOs.?				
4	Are you satisfied with your technical skillset gained during the degree program to cater the needs of the professional real-world scenarios? (PEO-I)				
5	Are you satisfied with the soft skills learnt during your				

degree program for the challenges of your professional life? (PEO-I)

6 Do you agree with the learning value (in terms of knowledge, concepts, manual skills, analytical abilities and broadening perspectives) of the BCE program? (PEO-IV)

7 Is the level of ethical and social responsibility you gained during the period of degree program good enough to contribute positively into the society? (PEO-II)

8 Are you satisfied with the level of success of your fellow graduates in learning new areas, emerging engineering designs and tools needed for the professional development? (PEO-III)

Do you want to suggest changes in PEOs statement? YES/NO
If yes, give suggestion here
……
……
……

Date: Signature:

BAHRIA UNIVERISTY, ISLAMABAD CAMPUS
Department of Computer Engineering

FEEDBACK FORM FOR PEOs FROM EMPLOYER

NAME:

DESIGNATION: ORGANIZATION:

PHONE NO. E-MAIL:

University VISION Statement
To become an internationally recognized university that contributes towards the development of nation through excellence in education and research.
University MISSION Statement
To remain committed to the attainment of highest standards in teaching, learning and research, at par with the international standards.
Department VISION Statement
Commitment to prepare students for professional and research activities with an ability to learn independently, within a diverse multi-cultural environment, and enabling them to become global leaders in their respective fields.
Department MISSION Statement
The mission of Computer Engineering program is to educate engineers by expanding knowledge and developing new methods/capabilities for solving complex technological problems through innovation in various domains of Computer Engineering e.g. digital design, networking and signal processing.

Program Educational Objectives (PEOs)

5. Attain an ability to identify and solve challenging problems in their professions applying theory, principles and modern tools learnt during degree program
6. Practice their professions conforming to public health and safety, high moral and ethical values
7. Demonstrate effective communication as an individuals or team players with strong managerial and entrepreneurial skills
8. Engage in life-long learning to continually polish their professional capabilities for their personal growth and the betterment of society

Dear Sir/Madam,

To maintain and enhance higher teaching and research practices at Bahria University, the department of Computer Engineering has enlisted a few *Program Educational Objectives(PEOs)* inline to the Washington Accord's consortium.

We shall very much appreciate and be thankful if you an spare some of your valuable time to fill up this feedback form and give us your valuable suggestions for further improvement of this process.

		Rating			
		1	**2**	**3**	**4**
S. No.	**QUESTIONS**	*Strongly Agreed*	*Agreed*	*Neutral*	*Disagreed*
1	Are you satisfied with the declared Program Educational Objectives (PEOs) of the Computer Engineering Department?				
2	According to your experience whether the current BCE program is compliant to the above mentioned PEOs?				
3	Whether the department is moving in the right direction towards the attainment of the said PEOs.?				
4	Are you satisfied with the level of technical contribution? (PEO-I)				
5	Are you satisfied with the soft skills learnt during your degree program for the challenges of your professional life? (PEO-I)				
6	Do you feel satisfied with the level of demonstrated ability to work well on a team? (PEO-IV)				
7	Are you satisfied with the level of ethical and social responsibility in contributing positively into the society? (PEO-II)				
8	Are you satisfied with the level of success in learning new areas, emerging engineering designs and tools needed for the professional development? (PEO-III)				

Do you want to suggest changes in PEOs statement? YES/NO
If yes, give suggestion here ……..
……
……
……

Thank you for your time.

Date: Signature:

Appendage 1417

PROPOSAL FOR LAUNCHING

PhD Geophysics Program

A. ACADEMIC DETAILS	
1	**Faculty/Department:** Faculty of Engineering and Sciences, Department of Earth and Environmental Sciences
2	**Name of the Program:** PhD Geophysics – PHD (GEO-PHY)
3	**Mission of the Program:** The mission of PhD Geophysics program is to build a strong and effective graduate program that will provide appropriate training and facilities to PhD candidates within the areas of expertise. The program will enhance research and professional skills and attract geoscientists of the national and international community. The department is committed to prepare, with a futuristic approach, competent professionals/researchers in the field of geophysics through quality education, quality research, field training, state-of-the art techniques and hands on commercial software as applied by the modern world.
4	**Objectives of the Program:** The PhD program has the following objectives: **(1)** A well-structured graduate teaching and training program in order to create opportunities for students with professional experience to achieve the highest educational standards. **(2)** Strong links with the international community of scientists and engineers working in the various fields

	of geophysical studies, both in academia and industry. **(3)** Advanced research possibilities in the fields of Earth Sciences and exploration of hydrocarbon particularly related to the oil and gas industry. **(4)** Enhance their knowledge through advanced course work, field works and use of dedicated software labs. **(5)** Development of oil, gas, minerals and water resources research programs of national, regional and international scope. **(6)** Enhance ability to present and defend a substantial piece of original research that makes a distinct contribution to the improvement of professional practice or policy in the field of geophysical sciences. **(7)** To provide high-potential manpower to the industry and organizations through an effective postgraduate learning-teaching process.
5	**Outcomes of the Program:** After completing the PhD coursework and thesis, the students will be able to: (1) Gain Fundamentals of geological modeling and reservoir characterization and propose solutions to geological problems (2) Apply geophysical techniques to image subsurface geology and/or the economic layers of the shallow and/or deep earth in more appropriate and acceptable modeling. (3) Conduct independently the research to provide solutions of the problems cropping up in the exploration of oil/gas and other resources. (4) Understand the potential theory and geophysical exploration techniques for the application of commercial industrial software in solving E & D projects. (5) Learn new trends of processing, modeling and interpret complex research findings related to current advances in geophysics.
6	**Rationale for the Program:** Geophysics is a leading discipline of modelling the Earth and is a major tool or technology of exploring the natural resources of the Earth. PhD Geophysics program is envisioned to contribute towards national efforts for producing professionals able to strengthen the research and education. The Department of Earth and Environmental Sciences desires to make Bahria University into a centre of national status and a focal point for geophysical research in the region. The Department had consensus to start the program in compliance with the role of universities to produce skilled, knowledgeable and motivated graduates for the industries and organizations in the private/public sectors.
7	**Brief Description of the Program:** The revised trends in industries dictate a preference for highly trained and specialized technical personnel, in order to strengthen the goals of the country for industrial growth and research in energy sector. The doctorate program in geophysical sciences is intended to prepare the competent scientists who can initiate genuine research ideas and come up

	with indigenous ideas to enrich the spectrum of geophysics and conduct particularly the Pakistan specific research in oil/gas and other geosciences resources. The doctoral program will provide training and education to the students with the objective of creating scholar capability to conduct research independently at a high level of originality and quality. The program is comprised of course work, field visits, exposure to digital technologies, training of industrial software and research thesis. The PhD degree is recognition of successful research experience of national and international standard in the discipline. This requires collaboration both with internationally reputed scientists and engineers and with leading centers of learning and research institutions. The PhD Geophysics program will cover fundamentals of geophysical exploration as well as geological knowledge in order to produce skilled researchers and innovative individuals in the field hydrocarbons and mineral exploration. PhD Geophysics program is being proposed as per requirements of Postgraduate Academic Regulations of Bahria University and HEC.
8	**Duration:** 3 years
9	**Venue(s): On Site~~/Off Site/Both On & Off Site~~** *(tick one/strike-through the ones not applicable; if Off Site, give details)* SIR SYED Block, Bahria University, Shangrilla Road, Sector E-8, Islamabad
10	**Programme Scheduling Format:** • ~~Morning~~**/<u>Evening</u>/**~~Weekend~~ *(tick one/strike-through the ones not applicable)* • ~~Bi Semester/Trimester/Semester+Summer Session/~~**<u>Annual</u>**~~/Bi Annual~~*(tick one/strike-through the ones not applicable)*
11	**Proposed Date of Commencement:** Fall 2018
12	**Mode of study** For the completion of the program the candidate must complete 54 credit hours (18 credit hours of course work in first two semesters and 36 credit hours for next four semesters allocated for thesis). He course work will be based on class room teaching, assignments, quizzes, presentations, mid-term and final term exams which will be used to evaluate the students in each semester. After the completion of course work with CGPA 3.0/4.0, the students will start their research theses on the approved synopses under the guidance of appointed supervisors. The students have to complete their theses within stipulated time frame. The candidates also require passing the PhD Comprehensive Examination before starting their research work.

13	**Additional Faculty Member(s) Required:** *(Indicate if there is a requirement for additional faculty members, fulltime/visiting, along with qualifications.)* One PhD Geophysics Faculty Member will be required who will be hired on IPFP to fulfill the HEC criteria of having three PhD faculty Members. As the Department already have two PhD Permanent Faculty Members.
14	**Additional Skilled-Worker(s) Required:** *(Indicate if there is a requirement for additional Skilled Staff, fulltime/part-time, along with their qualifications/skill sets.)* **None**
15	**Additional Classroom(s) required:** *(The requirement is to include the number of classrooms and their capacities.)* No extra class rooms will be required, the existing resources of SIR SYED Block will be utilized in the evening program.
16	**Additional Requirement for Laboratories:** *(The requirement is to include the number of laboratories, their equipment and their capacities.)* Establishment of a dedicated Digital Geophysical Software Lab of the Department of E&ES is in process where all the Licensed software available with the department will be installed and students MS and PhD programs could utilize and learn the geophysical data Interpretation in a dedicated work place. Along with the existing resources available in the department, lab facilities at other campuses of the Bahria University and of those organizations/institutions with which the Bahria has signed MOUs will be utilized.
17	**Additional Requirement for Books, Subscriptions, Memberships to Online Research Sites/ Repositories:** **None**
18	**Minimum Entry Level:** 18 years of education. MS/MPhil degree in Geophysics
19	**Admission Criteria:** HEC recognized MS/MPhil degree in Geophysics with 3.00/400 CGPA (Semester System) or 60% marks (Annual System) with Subject GAT/University Test Prior to admission.
20	**Additional/Different Examination Requirement** *(Indicate if there will be any examination requirement, additional to or different from the BU Academic Rules or Examination Policy in vogue).* No additional/different examination requirements. The examinations will be as per BU Academic Rules and Examination policy
21	**Number of Admissions Expected for First Intake:** 5 admissions for first intake
22	**Number of Admissions Planned/Expected for Subsequent Intakes:**

	5 admissions per intake
23	**Referred by: FBOS**
24	**Complete Plan of Studies, inclusive of complete Roadmap:** *(Attach as Annex 'A')*
25	**Course Outlines, Descriptions, Pre-Requisites & Readings (Compulsory & Recommended)** *(Attach as Annex 'B')*

B. FINANCIAL DETAILS

1 **Source of Funding: Tuition Fee**

- **BU: Fully/Partially:**
- **Public Sector (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)*
- **NNGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)*
- **INGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)*
- **UN/IGO (B1): Fully/Partially** *(provide complete details; attach MOU, agreement etc.)*

2 **Degree Duration:** 3 years

Semester System: Yes (6 Semesters)

Total Number of Credit Hours: 54

3 **Expected fee to be charged based on Cost & Benefits Analysis:** *(show working)*

Per annum fee: or Fee rate per credit hour: Rs. 5,775 /-

4 **Expected Number of students for 1st& 2nd Intakes:** 5 & 5

5 **Expected Earning from first two Intakes (B5):** *(Show working)*

Year	1st Intake				2nd Intake			
	Semester	Fee/Student	Students	Total Fee	Semester	Fee/Student	Students	Total Fee
1	Fall 2018	99,975	5	499,875	Fall 2019	99,975	5	499,875
	Spring 2019	56,975	5	284,875	Spring 2020	56,975	5	284,875
2	Fall 2019	56,975	5	284,875	Fall 2020	56,975	5	284,875
	Spring 2020	56,975	5	284,875	Spring 2021	56,975	5	284,875
3	Fall 2020	56,975	5	284,875	Fall 2021	56,975	5	284,875
	Spring 2021	56,975	5	284,875	Spring 2022	56,975	5	284,875
Total	1st Intake	1,924,250			2nd Intake	1,924,250		
	3,848,500							

6 **Expected Earning for the Next Five Years (B6):** *(show working)*

		Students			Fee per student		Total Fee		
Year	Semester	Fresh	Existing	Total	Fresh*	Existing**	Fresh	Existing	Total
1	Fall 2018	5	0	5	99,975	0	499,875	-	**499,875**
	Spring 2019	0	5	5	0	56,975	-	284,875	**284,875**
2	Fall 2019	5	5	10	99,975	56,975	499,875	284,875	**784,750**
	Spring 2020	0	10	10	0	56,975	-	569,750	**569,750**
3	Fall 2020	5	10	15	99,975	56,975	499,875	569,750	**1,069,625**
	Spring 2021	0	15	15	0	56,975	-	854,625	**854,625**
4	Fall 2021	5	10	15	99,975	56,975	499,875	569,750	**1,069,625**
	Spring 2022	0	15	15	0	56,975	-	854,625	**854,625**
5	Fall 2022	5	10	15	99,975	56,975	499,875	569,750	**1,069,625**
	Spring 2023	0	15	15	0	56,975	-	854,625	**854,625**

Year 1: Rs. 784,750 /-
Year 2: Rs. 1,354,500 /-
Year 3: Rs. 1,924,250 /-
Year 4: Rs. 1,924,250 /-
Year 5: Rs. 1,924,250 /-

Total 5 years earnings: Rs. 7,912,000 /- (7.912 million rupees)

* per credit 5775 with 9 credit hours including admission fee, caution money, degree fee and misc. charges

** per credit 5775 with 9 credit hours including misc. charges

7 **Total Estimated Salaries of all Additional Human Resources per annum (B7):** *(Show working)*

Year	Additional Human Resources (Thesis Payments)			
	Semester	**Description**	**Per Student**	**for 5 students**
1	**Fall 2018 and Spring 2019**	None	0	0
2	**Fall 2019 and Spring 2020**	None	0	0
3	**Fall 2020 and Spring 2021**	Payment to Supervisors	100,000	500,000
		Payment to foreign evaluators (Thesis)	60,000	300,000
		External and Internal Examiners (Proposal)	19,000	95,000
		External and Internal Examiners (Thesis)	19,000	95,000
		Miscellaneous (Field + Lab) work	100,000	500,000
		Total		**1,490,000**
4	**Fall 2021 and Spring 2022**	Payment to Supervisors	100,000	500,000
		Payment to foreign evaluators (Thesis)	60,000	300,000
		External and Internal Examiners (Proposal)	19,000	95,000
		External and Internal Examiners (Thesis)	19,000	95,000
		Miscellaneous (Field + Lab) work	100,000	500,000
		Total		**1,490,000**
5	**Fall 2022 and Spring 2023**	Payment to Supervisors	100,000	500,000
		Payment to foreign evaluators (Thesis)	60,000	300,000
		External and Internal Examiners (Proposal)	19,000	95,000
		External and Internal Examiners (Thesis)	19,000	95,000
		Miscellaneous (Field + Lab) work	100,000	500,000
		Total		**1,490,000**

Year 1: Rs. 0 /-
Year 2: Rs. 0 /-
Year 3: Rs. 1,490,000 /-
Year 4: Rs. 1,490,000 /-
Year 5: Rs. 1,490,000 /-

Total estimated expenses: Rs. 4,470,000 /-
Total estimated salaries of HR : Rs. 894,000 /- (per annum)

8 **Cost of <u>Additional</u> Laboratory Equipment/Tools (B8):** *(show working)*

None

9 **Cost of Additional Classrooms (B9):** *(Include furniture, technical aids etc)*

	None
10	**Cost of Additional Books, Subscription & Memberships to on-line Sites/Repositories (B10):** (*show details)* **None**
11	**Off-Site rental Expenses and Cost of other Fixtures (B11):** *(Show details)* **None**
12	**Miscellaneous Expenses required for Starting the Program (B12):** - Advertisement: 30,000 /- - Printing & Stationery: None - Admin Cost: None - Any other: None - **Total : 30,000 /-** -
13	**Annual Recurring Expenditures in Subsequent Years (B13):** - Salaries: - Rentals: - Subscriptions/Memberships: - Advertisements: - Printing & Stationery: - Admin Cost - Any other - **Total:**
14	**Total Cost of the Programme (B14):** [Add B(7) to B(12)] **Year 1: Rs. 30,000 /-** **Year 2: Rs. 0 /-** **Year 3: Rs. 1,490,000 /-** **Year 4: Rs. 1,490,000 /-** **Year 5: Rs. 1,490,000 /-**
15	**Net Cost of the Programme (B15):** [Subtract B(1) from B(14)] **Year 1: Rs. 30,000 /-** **Year 2: Rs. 0 /-** **Year 3: Rs. 1,490,000 /-** **Year 4: Rs. 1,490,000 /-** **Year 5: Rs. 1,490,000 /-**
16	**Net Earnings in First Year (B16:** [Subtract B(15) from B(5)] **Year 1: Rs. 754,750 /-**

17	**Projected Annual Gross Earning in Subsequent Years (B 17):** *(show details & working; add 10% towards all expenses in subsequent years.)* **Year 2: Rs. 1,489,950 /-** **Year 3: Rs. 2,116,675 /-** **Year 4: Rs. 2,116,675 /-** **Year 5: Rs. 2,116,675 /-**
18	**Projected Annual Net Earning in Subsequent Years:** *[Subtract B(15) from B(17)]* **Year 2: Rs. 1,489,950 /-** **Year 3: Rs. 626,675 /-** **Year 4: Rs. 626,675 /-** **Year 5: Rs. 626,675 /-**

Annex - A

ROADMAP FOR PHD GEOPHYSICS

Semester	Credit Hours
1	9 (Course Work)
2	9 (Course Work)
3 to 6	Comprehensive Exam. Synopsis Writing, Presentation & Final Thesis Defense
	36 (Research work)
Total Credit Hours	54

Semester - 1

Course Code	Course Title	Credit Hours
GEO 801	Tectonic Evolution of Pakistan	3
GEO 802	Geosciences Seminar	3
GEO 8xx	Elective course I	3

Semester – 2

Course Code	Course Title	Credit Hours
GEO 803	Seismic Imaging Technique	3
GEO 8xx	Elective course II	3
GEO 8xx	Elective course III	3

Elective Courses

Courses	Course Title	Credit Hours
GEO 820	3D Seismic Attributes for Reservoir Characterization	3
GEO 821	3D Seismic Acquisition in offshore & Onshore	3
GEO 822	Reservoir Modelling	3
GEO 823	GIS applications in Geophysics	3
GEO 824	Signal Processing in Geophysics	3
GEO 825	Geosciences Software	3
GEO 826	Disaster Risk Management	3
GEO 827	Advanced Reflection Seismology	3
GEO 828	Mining Geophysics	3
GEO 829	Advanced Earthquake Seismology	3
GEO 830	Gravity & Magnetic Modelling	3
GEO 810	Petrophysics	3
GEO 849	**Hydrocarbon Exploration Techniques**	**3**
GEO 850	**Advanced Basin Analysis**	**3**
GEO 851	**Reservoir Characterization**	**3**
GEO 853	**Advanced Sequence Stratigraphy**	**3**
GEO 868	**Advanced Structural Geology**	**3**
GEO 869	**Geostatistics**	**3**
GEO 871	**Advanced Petroleum Geology**	**3**
ESC 701	**Advanced Research Methodology**	**3**
GEO 872	Advanced Electrical Methods **(New Course Added)**	3

Note: Courses highlighted have been included from the PhD Geology Road Map

Annex – B

CORE COURSES OUTLINE FOR PHD GEOPHYSICS

1. GEO 801 Tectonic Evolution of Pakistan

Course outline:

Physiographic and tectonic divisions and their descriptions. Geology and stratigraphy of the, Indian plate, Karakoram plate, Afghan block and Arabian plate. Kohistan, Chagai and Ras Koh magmatic arcs, oroclines and suture zones. Regional metamorphism (Himalayan and Pre-Himalayan). Main episodes of magmatism and their relations to tectonics. Economic mineral and fuel deposits of Pakistan.

Reference text Books:

- Kearey, P., Klepeis, K.A., & Vine, F. J. (2013). *Global tectonics*. John Wiley & Sons.
- Kazmi, A. H., & Abbasi, I. A. (2008). *Stratigraphy & historical geology of Pakistan*. Department & National Centre of Excellence in Geology.
- Kazmi, A. H., & Jan, M. Q. (1997). *Geology and tectonics of Pakistan*. Graphic publishers.

2. GEO 802: Geosciences Seminar

Course outline:

The seminar topics will relate to specific areas of geophysical sciences that are not covered by existing courses. Students will give seminars and receive suggestions on literature review, methodology, geophysical modelling and research aspects. Members of the department and invited participants/speakers will also meet the students weekly to discuss current research in the world.

References: Student may take guideline from

- Supervisors, Experts from academia and Industry
- Case studies, Reports, Research papers etc.

3. GEO 803 Seismic Imaging Technique

Course outline:

The connection between seismic velocity and fluid flow, Seismic and reservoir resolutions, optimal grids, and scaling issues, Fundamentals of geostatistics fundamentals, Seismic attributes and facies, Seismic Inversion, poststack and prestack, Use of seismic, well log, core, pressure test and other data in reservoir model building, Neural networks and multi-attributes, Basic statistics, Markov Chain Monte Carlo simulations, and stochastic inversion, Uncertainty in reservoir models using Bayesian probability, 4D seismic analysis.

Reference Text Book:

- Griese, H. M. (2010). *Seismic imaging: a review of the techniques, their principles, merits and limitations*. EAGE publications.
- Sen, M. K. (2006). *Seismic inversion*. Richardson, TX.: Society of Petroleum Engineers.

4. GEO 810 Petrophysics

Course outline:

Review of basic logging objectives with focus on invasion profiles and challenges of borehole geophysics, Passive electrical properties of earth materials (porosity, permeability, saturation and porosity-permeability relations), Formation resistivity factor, Conductivity of shale, Reservoir/non-reservoir discrimination, Matrix-sensitivity logs, GR and SGR. Depth measurements and control, Borehole calipers, Porosity logs, Porosity log crossplots and mineralogy identification, Partially saturated rock properties and Archie Equation, Study of linear and logarithmic MOP (movable oil plot), Reconnaissance techniques, Rwa, FR/FP, logarithmic scaler, Porosity-resistivity cross plots, Permeability relationships, resistivity measuring tools, normal, induction & laterolog, FMI, nuclear magnetic resonance, Use of pressure measurements, Computerized log evaluation, Sidewall coring, Recommended logging programs, Technical and economic benefits of advanced well systems, Classification of advanced wells, Limitations and risk, Application of log in different oil prospect/ water, case studies

Reference Text Book:

- Tiab, D., & Donaldson, E. C. (2015). *Petrophysics: theory and practice of measuring reservoir rock and fluid transport properties*. Gulf professional publishing.
- Rider, M. H. (2011). *The geological interpretation of well logs.* 3rd Edition. Rider-French publishing.
- Ellis, D. V., & Singer, J. M. (2007). *Well logging for earth scientists* (Vol. 692). Dordrecht: Springer.
- Asquith, G. B., Krygowski, D., & Gibson, C. R. (2004). *Basic well log analysis* (Vol. 16). Tulsa: American Association of Petroleum Geologists.
- Rider, M. H. (2002). *The geological interpretation of well logs.* 2nd Edition. Rider-French publishing.

5. GEO 820 3D Seismic Attributes For Reservoir Characterization

Course outline:

Types of attributes, Impact of seismic data quality on seismic attributes, Methods for preconditioning of seismic data, Introduction of various algorithms for attribute computation, their limitations and performance strengths, Attribute expression of structure and stratigraphy in terms of tectonics and diaprism, clastic and carbonate depositional systems and geologic hazards, Multiattribute analysis tools, Reservoir characterization workflows, Physical demonstration of attributes on real seismic data., An inventory of direct hydrocarbon indicators, including AVO, AVO and how it relates to the typical production zones around the world with various ages and depths of burial, Spectral decomposition and seismic attributes as other ways of extracting reservoir information from the seismic image.

Softwares: Geographix, Petrel, Opendtect

Reference Text Book:

- Brown, A. R. (2011). *Interpretation of Three-Dimensional Seismic Data.* AAPG.
- Chopra, S., & Marfurt, K. J. (2007). *Seismic attributes for prospect identification and reservoir characterization*. Tulsa, Oklahoma: Society of Exploration Geophysicists.
- Davies, R. J. (Ed.). (2007). *Seismic geomorphology: Applications to hydrocarbon exploration and production*. Geological Society of London.
- Bacon, M., Simm, R., & Redshaw, T. (2007). *3-D seismic interpretation*. Cambridge University Press.

6. GEO 821 3D Seismic Acquisition in Offshore & Onshore

Course outline:

3D acquisition geometries, classes of 3D geometries, The continuous wavefield, 3D subsets and acquisition geometry, Sampling the continuous wavefield, minimal data sets, 3D symmetric sampling, Pseudo-COV gathers, application to prestack processing, Noise suppression, Properties of low-velocity noise. Guidelines for design of 3D geometry on land. Marine seismic data acquisition. Parameters of orthogonal geometry (fold, line intervals, maximum inline and maximum crossline offset). Converted waves: Properties and 3D survey design. Factors affecting spatial resolution. DMO. Prestack migration..

Reference Text Book:

- Vermeer, G. J. (2012). *3D Seismic Survey Design.* 2nd Edition. Tulsa: Society of Exploration Geophysicists.
- Vermeer, G. J., & Beasley, C. J. (2002). *3-D seismic survey design*. 1st Edition Tulsa: Society of Exploration Geophysicists.
- Cordsen, A., Galbraith, M., & Peirce, J. (2000). *Planning land 3-D seismic surveys* (Vol. 9). Tulsa: Society of Exploration Geophysicists.

7. GEO 822 Reservoir Modeling

Course outline:

Application of Various Imaging Techniques, Principles as Applied to Exploration and Reservoir Characterization, Concepts of Structural Interpretation, Lines/Cross-Lines, Arbitrary (User Defined) Lines, Time Slices, and Phase Slices, Visualization Techniques, Including 3D Immersion, Surface Versus Volumetric Interpretation, User-tracking Versus Auto-tracking of Horizons and Faults, Structural Interpretation, Including Refined Fault Analysis, Stratigraphic Interpretation, Including Sequence Stratigraphy and Appearance of Key Stratigraphic Features, Extraction of Petrophysical Information from Seismic Data, Integration of Well Log, Well Bore Geophysics, Synthetic Seismic, Seismic Inversion, Geological Analysis to Develop Coherent Reservoir Models.

Reference Text Book:

- Pyrcz, M. J., & Deutsch, C. V. (2014). *Geostatistical reservoir modeling*. Oxford university press.
- Luthi, S. (2013). *Geological Well Logs: Their Use in Reservoir Modeling*. Springer Science & Business Media.
- Ma, Y. Z., & La Pointe, P. R. (Eds.). (2011). *Uncertainty Analysis and Reservoir Modeling: Developing and Managing Assets in an Uncertain World.* AAPG.
- Veeken, P. C. (2006). *Seismic stratigraphy, basin analysis and reservoir characterization*. Elsevier.
- Slatt, R. M. (2006). *Stratigraphic reservoir characterization for petroleum geologists, geophysicists, and engineers*. Elsevier.

8. GEO 823 Remote Sensing & GIS Applications in Geophysics/Seismology

Course Outline:

GIS elements, Theory of GIS as: a science, a studies and a system, Type of geological an remote sensing data, GIS data formats, use of GIS in mineral and hydrocarbon exploration, GIS studies in geological and structural studies, spatial relationships and geological association, special case studies from Pakistan.

Reference Text Book:

- Liu, J. G., & Mason, P. J. (2016). *Image processing and GIS for remote sensing: Techniques and applications*. John Wiley & Sons.
- Burrough, P. A., McDonnell, R. A., & Lloyd, C. D. (2015). *Principles of geographical information systems*. Oxford University Press.
- Carrara, A., & Guzzetti, F. (Eds.). (2013). *Geographical information systems in assessing natural hazards* (Vol. 5). Springer Science & Business Media.
- Davis, J. C. (1989). *Digital geologic and geographic information systems*. American Geophysical Union.

Software: ArcGIS and other necessary

9. GEO 824 Signal Processing in Geophysics

Course outline:

This course emphasizes the application of time series analysis and image processing techniques to large geophysical data sets. The covered topics include Fourier series and transform, Discrete Fourier transform, Z-transform Digital signals aliasing and Nyquist concepts, Convolution and deconvolution, Inverse filtering and theory, Principle value decomposition, Signal enhancement and applications.

Reference Text Books:

- Zhou, H. W. (2014). *Practical seismic data analysis*. Cambridge University Press.
- Upadhyay, S. K. (2013). *Seismic reflection processing: with special reference to anisotropy*. Springer Science & Business Media.
- Onajite, E. (2013). *Seismic data analysis techniques in hydrocarbon exploration*. Elsevier.
- Vaseghi, S. V. (2008). *Advanced digital signal processing and noise reduction*. John Wiley & Sons.
- Yilmaz, Ö. (2001). *Seismic data analysis*. Tulsa: SEG Books.
- Robinson, E. A., & Treitel, S. (2000). *Geophysical Signal Analysis*. SEG Books.

10. GEO 825 Geosciences Software

Course outline:

Type of Formats (UKOOA, P-190 format, SEG-D, SEG—Y etc), Basic learning of UNIX and, LINUX, Scanning, Editing and QC of Data, Navigation data loading, Seismic data loading (SEG-Y files both 2D lines and 3D cube), Well data loading (Well locations, Formation tops, well logs etc), Preparation of Synthetic Seismogram, Generation of Horizon, Generation of Faults, Perform seismic visualization and interpretation, Velocity Model Building, Generation of Time and Depth Maps, 3D Visualization of Depth Surfaces, Crustal Shortening, Perform well correlation, Model faults, Model facies throughout the reservoir, Perform Petrophysical modeling, Calculate Reservoir volumes, Rock Physics Analysis, Complex trace attributes, Horizon and formation attributes, Color display and 3D visualization, Spectral decomposition and thin bed tuning, Geometric attributes, Attribute expression of structure and stratigraphy, Impact of data quality on seismic attributes, Structure-oriented filtering and image enhancement, Multi-attribute analysis tools.

11. GEO 826 Disaster Risk Management

Course outline:

Identification of Major disasters, Comparison of hazard mitigation to disaster preparedness, response, and recovery. Hazards management versus disaster management. Disaster

Modeling for Hazard Mitigation: Introduction to Inspiration Software and Disaster Modelling. Utilizing disaster models for conducting hazard and risk assessments, Atmospheric hazards and mitigations, Examine example disaster models prepared, Geologic/ Seismic Hazards and Mitigation, Hydrologic Hazards and Mitigation.

Reference Text Books:

- Olson, D. L., & Wu, D. D. (2017). Natural Disaster Risk Management. In *Enterprise Risk Management Models*. Springer, Berlin, Heidelberg.
- Ranke, U. (2016). *Natural Disaster Risk Management: Geosciences and Social Responsibility.* Springer
- Baas, S., Ramasamy, S., DePryck, J. D., & Battista, F. (2008). *Disaster risk management systems analysis: A guide book*(Vol. 3). Rome, Italy: Food and Agriculture Organization of the United Nations.

12. GEO 827 Advanced Reflection Seismology

Course Outline:

Principles of seismic reflection profiling, focusing on methods of seismic data formats advanced seismic reflection theories. Geometries of seismic waves, Characteristics of Seismic events, Seismic Resolutions, Fourier Transforms, Synthetics and Velocity Functions, Traveltime curves and velocity, Seismic Source Wavelets, Wavelet Shaping and Deconvolution. Seismic equipments, Reflection field methods, Data Processing and Seismic data Interpretation.

References Text Books:

- Liner, C. L. (2016). *Elements of 3D Seismology*. SEG Books.
- Wencai, Y. (2013). *Reflection Seismology: theory, data processing & interpretation*. Elsevier.
- Ashcroft, W. (2011). *A petroleum geologist's guide to seismic reflection*. John Wiley & Sons.
- Costain, J. K., & Çoruh, C. (2004). *Basic Theory in Reflection Seismology: with MATHEMATICA Notebooks and Examples on CD-ROM* (Vol. 1). Elsevier.
- Shearer, P. M. (2009). *Introduction to seismology*. Cambridge University Press.

13. GEO 828 Mining Geophysics

Course Outline:

Geophysical methods for exploration and mining, Geophysical prospecting, Electromagnetics, Resistivity, Induced Polarization, Self Potential, radiometric methods applied to problems in search for metallic mineral deposits, working conditions, data collections, processing and interpretation.

Reference Text Books:

Parasnis, D. S. (2014). *Mining geophysics.* (Vol. 3). Elsevier.

Idziak, A. F., & Dubiel, R. (Eds.). (2011). *Geophysics in mining and environmental protection*. Springer Science & Business Media.

14. GEO 829 Advanced Earthquake Seismology

Course Contents:

Earthquake Seismology, Seismic Wave Theory; Body Waves- Ray Theory and Ray Paths, Eikonal Equation, Travel Time Curves, Seismic Waveforms; Surface Waves-Dispersion Relations,Interpretation of Dispersion Curves, Group and Phase Velocities and Applications, Ambient Noise;The Earthquake Source- Focal mechanisms, moment tensors, source time function; Earthquake Mechanics- Friction and fracture, populations, dynamics, scaling; Seismic Recording - Sensors, recorders, networks and arrays; Seismograms-Natural and synthetic, time and frequency domain, combined influence of source, ray path, recording site and instrument; Earthquake Location- Ray parameters (arrays) and the Geiger method (networks); faulting source, double couple hypothesis, elastodynamics, Haskell's function, seismicmoment tensor, focal mechanism and fault plane solutions; seismic gaps;Global Earth Structure-Layered structure from travel time tables, 3D structure from seismic tomography; Seismotectonics-Distribution of seismicity in space, regional stress and strain tensors, relationship to tectonics; Seismic Hazard; Himalayan and stable continental region earthquakes, reservoir induced seismicity

Recommended Books:

Galea, D. (2016). Earthquake Seismology: Tools, Techniques and Instrumentation. Syrawood Publishing House.

Rafferty, J. P. (Ed.). (2010). Plate Tectonics, Volcanoes, and Earthquakes. The Rosen Publishing Group.

Stein, S., & Wysession, M. (2009). An introduction to seismology, earthquakes, and Earth structure. John Wiley & Sons.

Shearer, P. M. (2009). Introduction to seismology. Cambridge University Press.

Kayal, J. R. (2008). Microearthquake seismology and seismotectonics of South Asia. Springer Science & Business Media.

15. GEO 830 Gravity & Magnetic Modeling

Course outline:

Theoretical aspects of gravity, techniques of gravity & Magnetic techniques, principles of Gravity & Magnetic Data, field data processing and Isolation of residual and regional gravity and magnetic anomalies, Gravity & Magnetic Modelling.

Reference Text Books:

- Hinze, W. J., Von Frese, R. R., & Saad, A. H. (2013). *Gravity and magnetic exploration: Principles, practices, and applications*. Cambridge University Press.
- Kearey, P., Brooks, M., & Hill, I. (2013). *An introduction to geophysical exploration*. John Wiley & Sons.
- Mishra, D. C. (2011). Gravity and magnetic methods for geological studies. *Hyderabad: BS Publications*.
- Lowrie, W. (2007). *Fundamentals of geophysics*. Cambridge university press.

GEO 849 Hydrocarbon Exploration Techniques

Course Contents:

Hydrocarbon Exploration methods and techniques. Applications of different geophysical methods in hydrocarbon exploration like Gravity, electrical, Seismic, radioactive and well logging. Integration of different geophysical techniques, seismic interpretation, petrophysical analysis, volumetric reserves estimation, advance seismic techniques like attribute analysis, inversion, rock physics, AVO of pre and post stack seismic data, Characterization and Modeling of Petroleum System, Play Fairway Analysis.

Recommended Books:

- Onajite, E. (2017). *Practical Solutions to Integrated Oil and Gas Reservoir Analysis: Geophysical and Geological Perspectives*. Elsevier.
- Alsadi, H. N. (2017). *Seismic Hydrocarbon Exploration*. Springer International Publishing.
- Bjørlykke, K. (2015). *Petroleum Geosciences: From sedimentary Environments to Rock Physics*. Springer-Verlag Berlin Heidelberg.
- Onajite, E. (2013). *Seismic data analysis techniques in hydrocarbon exploration*. Elsevier.
- Miall, A. D. (2013). *The geology of fluvial deposits: sedimentary facies, basin analysis, and petroleum geology*. Springer.
- Kearey, P., Brooks, M., & Hill, I. (2013). *An introduction to geophysical exploration*. John Wiley & Sons.
- Sengbush, R. L. (2012). *Petroleum exploration: a quantitative introduction*. Springer Science & Business Media.

16. GEO 850 Advance Basin Analysis

Course Contents:

Basins in their plate tectonic environment, Understanding plate motion, Geophysical Processes in Sedimentary Basin Formation, Concept of structural Geology, The physical state of the lithosphere, Basins due to lithospheric stretching, Rifting and Passive margins, Rift Basin Architecture and Evolution, Quantitative Filling Model for Continental Extensional Basins, 3-D Diagram of a Rift Basin, Basin and Range province: The rise and fall of Death Valley's mountain ranges and valleys, Basins due to flexure, Gravity, Flexure and Basins relationship, Anatomy of a Mountain Belt: Foreland Thrust-and-Fold Belts, Alpine Foreland Basin in Southeastern France, Ebro Foreland Basin, Spain, Devonian Clastic Wedges of the Acadian Orogeny, N. America, Virtual field trip to the Apulia foreland basin, Basins associated with subduction zones, Basins associated with strike-slip deformation, Strike-slip faults, The sediment routing system, Basin Stratigraphy, Subsidence and thermal history, The petroleum play.

Recommended Books:

- Miall, A. D. (2013). *Principles of sedimentary basin analysis*. Springer Science & Business Media.
- Allen, P. A., & Allen, J. R. (2013). *Basin analysis: Principles and application to petroleum play assessment*. John Wiley & Sons.
- Miall, A. D. (2013). *The geology of fluvial deposits: sedimentary facies, basin analysis, and petroleum geology*. Springer.
- Veeken, P. C. (2006). *Seismic stratigraphy, basin analysis and reservoir characterisation*. Elsevier.

GEO 851 Reservoir Characterization

Course Contents:

Importance of understanding the various scales of heterogeneity in carbonate and clastic reservoirs, Reservoir rock deposition, diagenesis, mineralogy, rock textures, and pore types, Carbonate and clastic rock pore system classification, Reservoir rock properties and core analysis, Well log response, limitations, and strengths in reservoir rocks, Determination of lithology, porosity, and permeability, Fracture identification and distribution Porosity/depth relationships in limestone, dolomite and clastic reservoirs, Importance of sequence boundaries to development of pore architecture, Variations in carbonate pore architecture and its effect on permeability, Relationship of primary depositional facies, sequence stratigraphic framework and diagenetic history to pore architecture and reservoir quality, Controls on reservoir heterogeneity, from sub-reservoir to reservoir scale, Value of analogs for development of petrophysically-based reservoir models, Value and limitations of 3D geostatistical models to understand reservoir heterogeneity and architecture.

Recommended Books:

- Bjørlykke, K. (2015). *Petroleum Geosciences: From sedimentary Environments to Rock Physics*. Springer-Verlag Berlin Heidelberg.
- Lake, L. (Ed.). (2012). *Reservoir characterization*. Elsevier.
- Chopra, S., & Marfurt, K. J. (2007). *Seismic attributes for prospect identification and reservoir characterization*. Tulsa, Oklahoma: Society of Exploration Geophysicists.
- Lucia, F. J. (2007). *Carbonate reservoir characterization: An integrated approach*. Springer Science & Business Media.
- Slatt, R. M. (2006). *Stratigraphic reservoir characterization for petroleum geologists, geophysicists, and engineers*. Elsevier.
- Veeken, P. C. (2006). *Seismic stratigraphy, basin analysis and reservoir characterization*. Elsevier.
- Cubitt, J. M., England, W. A., & Larter, S. R. (Eds.). (2004). Understanding petroleum reservoirs: Towards an integrated reservoir engineering and geochemical approach. Geological Society of London.

17. GEO 853 Advanced Sequence Stratigraphy

Course Contents:

Introduction to seismic sequence stratigraphy; concepts; Eustatic controls; Assumptions; Definition of key terms., Eustatic controls on depositional stratal patterns, Accommodation and equilibrium types, Systems tract boundaries, Seismic expression of sequence, Criteria and approach for picking sequence boundaries, Interpretation of seismic reflections in depositional sequences, Definition of seismic sequence, Seismic facies, Sequence and systems tracts, Highstand, Falling stage, Lowstand, Transgressive, Shelf margin systems tracts, Sequence expression in well logs, Log characters of parasequences, Maximum flooding surfaces and criteria for picking sequence boundaries, Interpretation of systems tracts from well log character, Integration of well log sequence stratigraphy with seismic sequence stratigraphy, Clastic and carbonate depositional environments, Depositional responses to changes in relative sea level, Variation on the model: Application and exploration significance – use of global sea level curve, Introduction: review of philosophy and epistemology, Application of geophysical fundamentals (wave theory, attributes, frequency substitution, and coherency), Amplitude variation with offset (lithologies, fluids, gases, porosities, and pressures), Fault mechanical stratigraphy, Vail and Galloway sequence theory and application, High resolution sea level curve generation from micropaleo, Shallow and deep water siliciclastic sequences, Seismic facies and paleo-environmental analysis, Reservoir scale geophysics using the wavelet, Imaging hydrocarbons, Geohistory reconstruction, Optimizing exploration and development.

Recommended Books:

- Haq, B. U. (Ed.). (2013). *Sequence stratigraphy and depositional response to eustatic, tectonic and climatic forcing*. Springer Science & Business Media.
- Emery, D., & Myers, K. (Eds.). (2009). *Sequence stratigraphy*. John Wiley & Sons.
- Catuneanu, O. (2006). *Principles of sequence stratigraphy*. Elsevier.
- Veeken, P. C. (2006). *Seismic stratigraphy, basin analysis and reservoir characterization*. Elsevier.

18. GEO 868 Advanced Structural Geology

Course Contents:

Force, strain and stress (including Mohr diagram and strain analysis methods); Deformation dynamics, kinematics and structures; Deformation modes and mechanisms; Brittle rock deformation: faulting (including fault rock development, fault seal analysis and palaeostress analysis from fault slip data) and fracturing (including joint development) in the upper crust; Ductile rock deformation: folding and shear zone development, lithospheric extension models, development of rift basins and passive margins and stretching factors; lithospheric compression models and development of foreland fold and thrust belts;diagram techniques, construction and interpretation of block diagrams and contour maps, stereographic analysis, cross section construction, restoration and balancing, 4D cross section evolution

Recommended Books:

- Fossen, H. (2016). *Structural geology*. Cambridge University Press.
- Ghosh, S. K. (2013). *Structural geology: fundamentals and modern developments*. Elsevier.
- Park, R. G. (2013). *Foundation of structural geology*. Routledge.
- Davis, G. H., Reynolds, S. J., Kluth, C. F. (2011). *Structural Geology of Rocks and Region*. 3rd Edition. Wiley Publishing.
- Twiss, R. J., & Moores, E. M. (2006). *Structural geology*. W. H. Freeman.
- Pollard, D. D., & Fletcher, R. C. (2005). *Fundamentals of structural geology*. Cambridge University Press.

19. GEO 869 Geostatistics

Course Contents:

Introduction to geostatistics; computer application in geo-statistics, collection of data: collection of primary data, collection of secondary data, editing of data; measures of central tendency or averages, types of averages, the arithmetic mean,the median, the mode, empirical relation between mean, median and mode, relative merits and demerits of various averages; measures of dispersion range, semi-interquartile range or quartile deviation, mean deviation, standard deviation, skewness; correlation and simple regression, coefficient of correlation, scatter diagram, rank correlation, regression; geo-statistical analyst: powerful exploration and data interpretation solutions multiple tools for data representation; The variogram calculation, interpretation, linking variogram behaviour with physical causes (geology, sampling); Extension variances and estimation variances/simple calculations in one and two dimensions; Global reserve/resource estimation; Optimal estimation and introduction to kriging;

Recommended Books:

- Hohn, M. (2013). *Geostatistics and petroleum geology*. Springer Science & Business Media.
- Wackernagel, H. (2013). *Multivariate geostatistics: an introduction with applications*. Springer Science & Business Media.
- Chilès, J. P., & Delfiner, P. (2012). Geostatistics: Modeling Spatial Uncertainty. Wiley Publishing.
- Armstrong, M. (2012). *Basic Linear Geostatistics*. Springer Science & Business Media.

20. GEO 871 Advanced Petroleum Geology

Course Contents:

Review of Petroleum Geology; Petroleum Geochemistry / Source Rock Evaluation; Modeling of Thermal History and Petroleum Generation and Expulsion; Production Seismic; Basin Analysis; Reservoir Geology & Reservoir modeling; Volumetric Reserve Estimation; Field Appraisal; Integrated Geology Workshop; Sequence Stratigraphy.

Recommended Books:

- Bjørlykke, K. (2015). *Petroleum Geosciences: From sedimentary Environments to Rock Physics*. Springer-Verlag Berlin Heidelberg.
- Selley, R. C., & Sonnenberg, S. A. (2014). *Elements of petroleum geology*. Academic Press.
- Gluyas, J., & Swarbrick, R. (2013). *Petroleum geoscience*. John Wiley & Sons.
- Zou, C. (2017). *Unconventional petroleum geology*. Elsevier.
- Chapman, R. E. (2000). *Petroleum geology* (Vol. 16). Elsevier.
- North, F.K. (1985). *Petroleum geology*. Springer.

21. ESC 701 Advanced Research Methodology

Course Contents:

Research paradigms; techniques and pre-requisites of scientific research; research concept development; critical thinking and developing of research question; writing research proposal and its importance for acquisition of funds/grants from various agencies; the logic of sampling; sampling design; experimental work to address relevant analytical techniques; analytical data handling and presentation skills; relevant software utilization; thesis writing; paper review technique; techniques of research paper publication in journals of repute

Recommended Books:

- How to Research, L. Blaxter, C. Hughes, M. Tight, 4th Edition, 2010.
- Research Methodology: A Step-by-Step Guide for Beginners, Ranjit Kumar, Publisher: SAGE,3rd Edition, 2010

- Wayne C. Booth, Gregory G. Colombo, Joseph M. Williams, 2008, The Craft of Research (Chicago Guides to Writing, Editing, and Publishing). University Of Chicago Press , 336
- Creswell, J.W, 2006, Designing and Conducting Mixed Methods Research. Sage Publications (CA). 275
- Research Methodologies – A step by step guide for beginners, Ranjit Kumar, 2005.
- Dawson, C. 2002, Practical Research Methods, A user-friendly guide to mastering research. Cromwell Press, Trowbridge, Wiltshire. 169
- William R. Shadish, Thomas D. Cook, Donald T. Campbell, 2001, Experimental and Quasi-Experimental Designs for Generalized Causal Inference. Houghton Mifflin. 623

22. GEO 872 Advanced Electrical Methods

Course Contents:

Basic principal and theory of Electrical Resistivity method . Fundamentals of current flow in the Earth. Electric potentials and fields. Static charge distributions. Resistivity Imaging study its survey designing for Geophysical Electrical Exploration. Field procedures including Instruments and electrode arrangements. Processing and interpretation of resistivity data. Its limitations, advantages and disadvantages. Basic principal and theory of Induced polarization method its field procedure, data acquisition, interpretation, limitations, advantages and disadvantages. Basic principal and theory of Self potential method its field procedure, data acquisition, interpretation, limitations, advantages and disadvantages. Basic principal and theory of Electromagnetic method including Telluric Method and Magneto telluric Method, survey designing, data acquisition, interpretation, limitations, advantages and disadvantages. Basic principal and theory of Charge body potential Method Mise A La Masse method and its applications. Study of case histories of all electrical methods.

Recommended Books:

- Kaufman, A. A., Alekseev, D., & Oristaglio, M. (2014). *Principles of electromagnetic methods in surface geophysics*. Newnes.
- Fitch, A. A. (Ed.). (2012). *Developments in Geophysical Exploration Methods—3*. Springer Science & Business Media.
- Fitch, A. A. (Ed.). (2012). *Developments in Geophysical Exploration Methods—3*. Springer Science & Business Media.
- Kaufman, A. A., & Anderson, B. (2010). *Principles of electric methods in surface and borehole geophysics*. Elsevier.
- Yungul, S. H. (1996). *Electrical methods in geophysical exploration of deep sedimentary basins*. Springer.

Department of Earth and Environmental Sciences

PhD Faculty of the Department

A) Permanent PhD Faculty

1.	Prof. Dr. Tahseenullah Khan (HOD)	Geology, (HEC Approved Supervisor)
2.	Prof. Dr. Muhammad Zafar	Earth Sciences (HEC Registered Supervisor)
3.	Dr. Abid Ali	Geophysics
4.	Dr. Muhsan Ehsan	Geophysics
5.	Dr. Nosheen Sahir	Geology
6.	Dr. Humera Farah	ES

7. Dr. Said Akbar Khan ES
8. Dr. Aansa Rukya ES
9. Dr. Asma Jamil ES

B) Visiting PhD Faculty

1. Dr. Muhammad Iqbal Hajana Geophysics
2. Dr. Birkhez Aslam Shami Geology
3. Dr. Samina Jehandad Geochemistry
4. Dr. Ali Wahid Petroleum Geosciences

Appendage 1418

Revision of Departmental Vision, Program Mission, PEOs & PLOs for BSE Program

1. As per PEC new regulation, "it should be ensured that the program mission and objectives are aligned with the vision of the institution. Program mission and objectives should be articulated and made know to everyone in the institution through institutional publications and websites."
2. In this regards, revisions in departmental vision and program's mission, educational objective and learning outcomes have been carried out to ensure proper alignment of all of these aspects.

Recommendation.

Revised Departmental Vision, Program Mission and Educational Objectives & Learning Outcomes is submitted for approval and onward submission to ACM.

Department of Software Engineering

Bachelor of Software Engineering Program

Vision Statement of the Department

Department of Software Engineering aims to be recognized as a leader in Software Engineering education and research through excellence in modern education and targeted research in emerging areas of Software Engineering.

Program Mission - Bachelor of Software Engineering

The mission of Bachelor of Software Engineering program is to prepare technically strong Software Engineers who can contribute effectively towards the nation, society and the world at large through effective problem solving skills, application of engineering knowledge, leadership and healthy lifelong learning attitude.

Program Educational Objectives

Software Engineering department aims to deliver a strong and coherent Software Engineering program for the development of skilled manpower. The curriculum is inline with PEC and HEC regulations to equip students with latest skills for industry and research activities. Software Engineering graduates will be able to demonstrate the following:

PEO-1: The ability to design, synthesize, and analyze, software systems of increasing size and complexity at various abstraction levels, starting from individual component and all the way to the entire system architecture.

PEO-2: The ability to define, assess, and tailor software processes, quality practices and methodologies for application in software development in a variety of application domains.

PEO-3: The ability to demonstrate awareness regarding societal context and ethical responsibility in professional practices.

PEO-4: The ability to communicate to varied stakeholder audiences, technical concepts in a complete, concise, and correct manner in a format appropriate for the audience.

PEO-5: The ability to pursue life-long learning through graduate education, participation in professional activities, or the acquisition of new technical proficiency, or managerial and leadership skills.

Program Learning Outcomes

PLO 1: Engineering Knowledge: An ability to apply knowledge of computer science, software engineering fundamentals and an engineering specialization to the solution of complex software engineering problems.

PLO 2: Problem Analysis: An ability to identify, formulate, research literature and analyze complex software engineering problems reaching substantiated conclusions using software engineering principles, natural sciences and engineering sciences.

PLO 3: Design/Development of Solutions: An ability to design solutions for complex software engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO 4: Investigation: An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis, and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO 5: Modern Tool Usage: An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO 6: The Engineer and Society: An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO 7: Environment and Sustainability: An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PLO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO 9: Individual and Team Work: An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

PLO 10: Communication: An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PLO 11: Project Management: An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

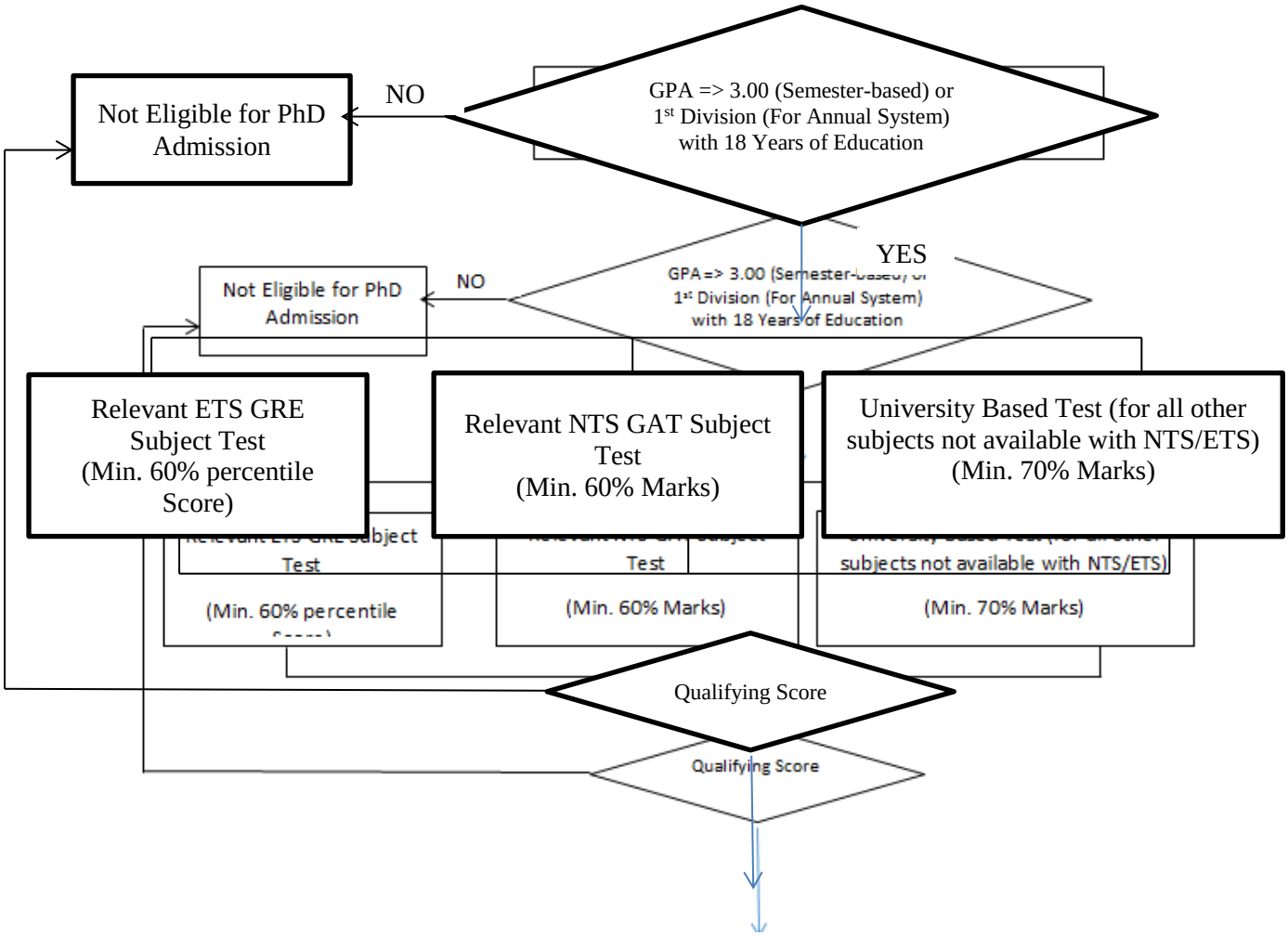
PLO 12: Lifelong Learning: An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

Appendage 1419-1

PhD Program Structure & Requirements

The PhD program consists of 18 credit hours of course work and 36 credit hours of research work. Coursework should be completed in the first two semesters. After successful completion of coursework, a PhD scholar is required to appear in the comprehensive examination. After passing comprehensive examination PhD scholar can register in the research phase by registering THS 900 PhD Thesis course. The first milestone in research phase is to prepare and submit a research Proposal under the guidance of a supervisor. The scholar appears before a panel of examiners to defend the research proposal. After successful defense, the scholar needs to carry out his/her research and complete total 36 credits of research. The scholar will present the research finding in the form of a written thesis, which shall be evaluated as per HEC and BU rules. For further details about rules governing PhD programs refer to PhD Rules Handbook.

Following flow chart shows the overall structure and requirements of the PhD program as per BU Rules.


Not Eligible for PhD Admission
NO
GPA => 3.00 (Semester-based) or 1st Division (For Annual System) with 18 Years of Education
YES
Not Eligible for PhD Admission
NO
GPA => 3.00 (Semester-based) or 1st Division (For Annual System) with 18 Years of Education
Relevant ETS GRE Subject Test (Min. 60% percentile Score)
Relevant NTS GAT Subject Test (Min. 60% Marks)
University Based Test (for all other subjects not available with NTS/ETS) (Min. 70% Marks)
Test
(Min. 60% percentile
Test
(Min. 60% Marks)
subjects not available with NTS/ETS)
(Min. 70% Marks)
Qualifying Score
Qualifying Score

Bahria University
Discovering Knowledge

PhD in Software Engineering

Department of Software Engineering

BAHRIA UNIVERSITY

PhD in Software Engineering

Introduction

PhD in Software Engineering focuses on advancement of theory and practice in the area of Software Engineering and relevant computing domains. Software Engineering discipline is highly inter-disciplinary including application of mathematical, computer science, systems and software engineering concepts. PhD Software Engineering program thus focuses on producing well-educated researchers who can contribute by creation of new knowledge and propose solutions to challenges faced by the practitioners and researchers of the discipline.

Program Mission

To enhance the theory and practice in the domain of Software Engineering by creation of new knowledge and highly qualified academicians and fostering innovation in the core areas of Software Engineering and applied computing disciplines.

Program Educational Objectives

The objectives of PhD (Software Engineering) program are:

1. To equip scholars with necessary knowledge, relevant tools and techniques to make significant contribution in the field of study by conducting quality research independently or in collaboration.
2. To prepare scholars to effectively disseminate result in the form of written and oral presentation
3. To produce skilled professionals who can take up the challenges associated with the advancement of science and technology in industry or in academia.

Program Learning Outcomes

PhD scholars who successfully complete their PhD in Software Engineering will be able to:

PLO 1: Synthesize content knowledge, concepts, and principles grounded in the domain of Software Engineering and relevant allied disciplines (Engineering, Mathematics and Computing).

PLO 2: Design and conduct research that is grounded in theory, practice and further extends the existing research in the field.

PLO 3: Conduct research that positively impacts the domain and society.

PLO 4: Communicate effectively both in oral and written formats to a diverse audience.

PLO 5: Collaborate with the peers in the domain of Software Engineering and computing to integrate diverse perspectives.

Program Structure

The PhD program consists of 18 credit hours of course work and 36 credit hours of research work. Coursework should be completed in the first two semesters. After successful completion of coursework, a PhD scholar is required to appear in the comprehensive examination. After passing comprehensive examination PhD scholar can register in the research phase by registering THS 900 PhD Thesis course. The first milestone in research phase is to prepare and submit a research Proposal under the guidance of a supervisor. The scholar appears before a panel of examiners to defend the research proposal. After successful defense, the scholar needs to carry out his/her research and complete total 36 credits of research. The scholar will present the research finding in the form of a written thesis, which shall be evaluated as per HEC and BU rules. For further details about rules governing PhD programs refer to PhD Rules Handbook.

Semester wise breakdown of the program is as follows.

SEMESTER I		
Course code	**Subject**	**Credits**
	Course Work (Student shall study 3 courses)	9
	Total credits for 1st semester	9
SEMESTER II		
Course code	**Subject**	**Credits**
	Course Work (Student shall study 3 courses)	9
	Total credits for 2nd semester	9
SEMESTER III		
Course code	**Subject**	**Credits**
	Comprehensive exam	0
THS-900	PhD Thesis	9
	Total credits for 3rd semester	9
SEMESTER IV		
Course code	**Subject**	**Credits**
THS-900	PhD Thesis	9
	Total credits for 4th semester	9
SEMESTER V		
Course code	**Subject**	**Credits**
THS-900	PhD Thesis	9
	Total credits for 5th semester	9
SEMESTER VI		
Course code	**Subject**	**Credits**
THS-900	PhD Thesis	9
	Total credits for 6th semester	9
Total credit for PhD program		**54**

PhD Coursework

1. A PhD scholar will select 6 courses in consultation and approval of supervisor/advisory committee from the following list of courses.

2. Scholar can choose minimum of 3 courses from Category-1 courses and maximum of 3 courses from Category-2 courses. Scholar will also be able to take all 700+ courses from MS Software Engineering program as Category-1 courses.
3. Relevant 700+ courses of MS/PhD programs in Computer Science, Data Science and Information Security will be inclusive in category-1 or 2 based on subject area. Supervisor/Advisory committee will decide about the relevance of such courses for each scholar.
4. It is mandatory to study ESC 701 Research Methodology, if the scholar has not studied this or equivalent course in MS program.

S#	Course Code	Title of Course	Cr. Hrs.
Category-1 Software Engineering & Information Systems			
1	SEN 720	Advanced Human Computer Interaction	3
2	SEN 756	Advanced Usability Engineering	3
3	SEN 723	Formal Methods and Specifications	3
4	SEN 763	Advanced Software Engineering	3
5	SEN 759	Software Re-Engineering	3
6	SEN 758	Component-Based Software Engineering	3
7	SEN 812	Agile Methods	3
8	SEN 815	Verification and Validation	3
9	SEN 813	Advanced Software Requirements Engineering	3
10	SEN 757	Empirical Software Engineering	3
11	SEN 801	Model Driven Software Engineering	3
12	SEN 802	Special Topics in Software Engineering	3
13	SEN 754	Advanced Web Computing System and Application	3
14	SEN 755	Service Oriented Computing	3
15	SEN 816	Middleware For Networked and Distributed Systems	3
16	CSC 781	Cloud Computing	3
17	CEN 707	Advanced Distributed Systems	3
18	SEN 803	Advanced e-Learning Systems	3
19	SEN 761	Advanced Semantic Web	3
20	SEN 764	Ontology Engineering	3
21	SEN 760	Complex Adaptive Systems	3
22	CEN 708	Advanced System Modeling and Simulation	3
23	CSC 759	Agent Based Modeling	3
24	SEN 762	Advanced Big Data Analytics	3
25	CSC 711	Advanced Artificial Intelligence	3
26	CSC 741	Advanced Natural Language Processing	3
27	CSC-749	Advanced Neural Networks and Fuzzy Logic	3
28	CSC 751	Pattern Recognition	3
29	CSC 746	Advanced Data Mining	3
30	CSC 760	Advanced Data Warehousing	3
31	CSC 801	Advanced Information Retrieval	3
32	CSC 719	Machine learning	3
33	DSC-703	Data Visualization	3
34	DSC-705	Deep Learning and Data Analysis	3
35	CSC 747	Text Mining	3
36	CSC 764	Computer Vision	3
37	CSC 765	Bio Medical Image Analysis	3
38	CSC 701	Computer Supported Cooperative Work	3
39	CEN 745	Advanced Digital Image Processing	3
40	CSC 750	Intelligent Tutoring System	3

Category-2 Computing & Cross Domain Courses			
1	ESC 701 *	Research Methodology	3
2	GSC 700	Advanced Engineering Mathematics	3
3	CEN 764	Design of Fault-Tolerant Systems	3
4	SEN 753	Power Aware Computing	3
5	SEN 814	Ubiquitous Computing and Interaction	3
6	CSC 704	Advanced Cryptography	3
7	CSC 720	Advanced Operating Systems	3
8	CSC 744	Advanced Computer Graphics	3
9	CSC 753	Distributed Databases	3
10	CSC 757	IP Multimedia System	3
11	CSC 758	Parallel Processing	3
12	CEN 720	Advanced Computer Architecture	3
13	CSC 754	Object Oriented Databases	3
14	CSC 755	Web Based DBMS	3
15	CSC 756	Multimedia Databases	3
16	EET 710	Advanced Computer Networks	3
17	EET 726	Advanced Internet Technologies	3
18	EET 702	Advanced Network Security	3
19	CEN 740	Advanced Embedded Systems	3
20	CEN 742	Advanced Digital System Design	3
21	EET 850	Wireless Sensor Networks	3
22	EET 851	Mobile and ad-hoc Networks	3
23	EEN 725	Advanced Digital Signal Processing	3

*It is mandatory to study ESC 701 Research Methodology, if the scholar has not studied this or equivalent course in MS program.

Course outlines for New Courses

Course Title: Special Topics in Software Engineering
Course Code: SEN 802
Credit Hours: (03)
Course Description:
Theories, concepts, tools and techniques are changing very rapidly in the domain of Software Engineering. Moreover, research issues are very diversified ranging from software processes, design, implementation techniques, testing and quality, project management to application of modern methods from computer science domain. This course will focus covering classical and contemporary research issues in a particular area of research in the domain of Software Engineering to meet the requirements of a particular research scholar.

On successful completion of this course, students will be able to:

- Have an opportunity to study advanced topics in areas of research and new technologies in Software Engineering based on their research area/topic.
- To present current research issues in areas of Software Engineering.
- Understand the new developments in Software Engineering that are not already covered in other parts of the degree program.

Recommended Books/Reading Materials:

3. Classical reading in Software Engineering from renowned journals and conferences of Software Engineering domain.
4. Contemporary readings of very high significance covering latest research issues from renowned journals and conferences of Software Engineering domain.

Course Title: Model Driven Software Engineering
Course Code: SEN 801
Credit Hours: (03)
Course Description:
This course Model Driven Software Engineering (MDSE) aims enables students to understand in depth the fundamental principles of structural and behavior modelling and know how to apply models for architecture, requirements and process description. Various methodologies and approaches to MDSE – Model-driven architecture (MDA), model-driven engineering, model-driven development & verification. Details and up to date research nodes emphasis to principles and concepts underlying model-driven software engineering, approaches for defining the syntax and semantics of domain-specific modelling languages, objects, object orientation, OOM, MM, MT. Essentials and planning, responsibilities, scheduling, verification risk in Models, MDA and MDSE.
Upon completion of this course, the students will be able to:

- Understand core concepts related to MDA, MDD and MDT.
- Apply these concepts for effective software system design
- Understand contemporary research issues in the domain of Model Driven Software Engineering

Recommended Books/Reading Materials:

1. Model-Driven Software Engineering in Practice: Second Edition (Synthesis Lectures on Software Engineering) 2nd Edition. By Marco Brambilla, Jordi Cabot, and Publisher: Morgan & Claypool Publishers, 2017.
2. Model-Driven Software Development: Technology, Engineering, Management 1st Edition, by Thomas Stahl , Markus Voelter , Krzysztof Czarnecki, Publisher Wiley;

ISBN-10: 0470025700.

Course Title: Empirical Software Engineering
Course Code: SEN 757
Credit Hours: (03)
Course Description:
With the passage of time, there has been ever increasing focus of Software Engineering community on evidence based and empirical studies in the domain. Eventually it will lead to experimental Software Engineering with more focused and scientific research finding. Empirical methods such as controlled experiments, case studies, surveys and post-mortem analyses are helpful to help us evaluate and validate the research results. This course will enable the scholars to learn about various types of empirical research techniques including experiments, case study, Post-mortem analysis in the context of Software Engineering domain. Upon completion of this course, the students will be able to:

- Understand the need, concepts and applications of various empirical methods
- Understand, analyze and critically evaluate already published empirical studies in the domain
- Apply, design and execute a particular research study based on an appropriate empirical research method.

Recommended Books/Reading Materials:

5. Ruchika Malhotra, "Empirical Research in Software Engineering, Concepts, Analysis and Applications", CRC Press, 2016.
6. Per Runeson, Martin Host, Austen Rainer, Bjorn Regnell, “Case Study Research In Software Engineering; Guidelines And Examples”, John Wiley & Sons, 2012.

Course Title: Advanced eLearning Systems
Course Code: SEN 803
Credit Hours: (03)
Course Description:
E-learning is a multibillion dollar global industry that continues to evolve, with everything from 100% online class offerings to web-enhanced on-campus classroom environments. Students will research and practice hands-on application in visioning, planning and designing of e-learning environments in light of learning theories and styles. This course will provide an in-depth knowledge of curriculum development, design and course delivery via technology and online learning management systems. Students will examine e-learning from aspects such as law, technology resources, teaching and learning in synchronous and asynchronous environments, and instructional design.
Upon completion of this course, the students will be able to:

- Develop leadership skills to support educational practices across diverse instructional and organizational settings.
- Analyze educational theories and research supporting diverse instructional practices.
- Understand and discuss about educational theories, research, and practices.
- Evaluate evidence-based solutions for addressing educational, organizational, and societal issues

Recommended Books/Reading Materials:

3. Harasim, Linda. (2017) Learning Theory and Online Technologies. 2nd edition. New York: Routledge.

Course Title: Intelligent Tutoring Systems
Course Code: SEN 750
Credit Hours: (03)
Course Description:
This course addresses the use of Artificial Intelligence to create computer-based Intelligent Tutoring Systems (ITSs). Students will learn data-driven and theoretical methods for creating ITSs. ITSs have been demonstrated to dramatically enhance student learning in many domains, including, to name a few, mathematics, computer science, medicine, biology and engineering. In addition to discussion and readings about methods and models of problem solving, learning, and tutor design, the course will have a "learning by doing" component.
Upon completion of this course, the students will be able to:

- Understand key ideas in the area of Artificial Intelligence in Education.
- Understand the basics of psychology of learning.
- Explain the functionality of ITSs.
- Critically assess approaches to student modelling in ITSs.
- Design constraints and production rules for use in ITSs.
- Design and develop small-scale constraint-based tutors
- Evaluate ITSs
- Understand and assess current research topics in the area of Artificial Intelligence in Education

Recommended Books/Reading Materials:

4. Building Intelligent Interactive Tutors: Student-centered strategies for revolutionizing e-learning by Beverly Park Woolf; published by Morgan Kaufmann. (2009)
5. Relevant research papers and case studies

Bahria University
Discovering Knowledge

PhD in Electrical Engineering

Department of Electrical Engineering

BAHRIA UNIVERSITY

Introduction:

The Doctor of Philosophy (PhD) program in Electrical Engineering prepares graduates for industrial or academic research in the fields of Communication, Embedded System, Control, and Power System Engineering. PhD Electrical Engineering program focuses on producing skilled researchers who can contribute by creation of new knowledge and propose solutions to challenges faced by the practitioners and researchers of the discipline.

Program Mission:

The PhD in Electrical Engineering strives to provide an environment, which is conducive to create new knowledge, for independent or collaborative research, and to produce highly skilled professional and academicians.

Program Educational Objectives

The objectives of PhD (Electrical Engineering) program are

1. To equip scholars with necessary knowledge relevant tools and techniques to make significant contribution in the field of study by conducting quality research independently or in collaboration.
2. To prepare scholars to effectively disseminate result in the form of written and oral presentation
3. To produce skilled professionals who can take up the challenges associated with the advancement of science and technology in industry or in academia.

Program Learning Outcomes

PhD scholars who successfully complete their PhD in Electrical Engineering will be able to:

PLO 1: Perform advance research that is grounded in theory, practice and further extends the existing research in the field

PLO 2: Produce quality research that have a positive impact toward the welfare and betterment of society

PLO 3: Communicate effectively both in oral and written formats to a diverse audience.

PLO 4: Collaborate with the peers in the domain of Electrical Engineering to integrate diverse perspectives

Program structure:

The PhD program consists of 18 credit hours of course work and 36 credit hours of research work. Coursework should be completed in the first two semesters. After successful completion of coursework, a PhD scholar is required to appear in the comprehensive examination. After passing comprehensive examination PhD scholar can register in the research phase by registering THS 900 PhD Thesis course. The first milestone in research phase is to prepare and submit a research Proposal under the guidance of a supervisor. The scholar appears before a panel of examiners to defend the research proposal. After successful defense, the scholar needs to carry out his/her research and complete total 36 credits of research. The scholar will present the research finding in the form of a written thesis, which shall be evaluated as per HEC and BU rules. For further details about rules governing PhD programs refer to PhD Rules Handbook.

Semester wise breakdown of the program is as follows.

SEMESTER I

Course code	Subject	Credits
	Course Work (Student shall study 3 courses)	9
	Total credits for 1st semester	9

SEMESTER II

Course code	Subject	Credits
	Course Work (Student shall study 3 courses)	9
	Total credits for 2nd semester	9

SEMESTER III

Course code	Subject	Credits
	Comprehensive exam	0
THS-900	PhD Thesis	9
	Total credits for 3rd semester	9

SEMESTER IV

Course code	Subject	Credits
THS-900	PhD Thesis	9
	Total credits for 4th semester	9

SEMESTER V

Course code	Subject	Credits
THS-900	PhD Thesis	9
	Total credits for 5th semester	9

SEMESTER VI

Course code	Subject	Credits
THS-900	PhD Thesis	9
	Total credits for 6th semester	9
Total credit for PhD program		**54**

Core Courses

- Student shall register at least 3 courses from the list of Electrical Engineering courses.
- EE courses offered in MS programs at Bahria University with course code **7XX** shall be considered as part of Electrical Engineering courses for PhD (EE).
- Student can take 700+ courses from MS CS/EE/SE/Data Science and IS programs. Supervisor/Advisory committee will decide about the relevance of such courses for each scholar.

S#	Course Code	Title of Course	Cr. Hrs.
1	EET762	Communication Networks Arch & Protocols	3
2	EET766	RF System Engineering and Design	3
3	EET750	Antennas Theory , Design and Applications	3
4	EET755	Wireless Communication Techniques	3
5	EET756	Telecommunication Switching Systems	3
6	EET706	Advanced Optical Fiber Networks	3
7	EET725	Advanced Routing and Switching	3
8	EET726	Advanced Internet Technologies	3
9	EET723	Optimization Techniques	3
10	EET713	Advanced Network Design	3

11	EET757	Mobile Computing	3
12	EET702	Advanced Network Security	3
13	EET 850	Wireless Sensor Networks	3
14	EET 851	Mobile and ad-hoc Networks	3
15	EET727	Cognitive Cooperative Networks	3
16	EET 711	Advanced Digital Communications	3
17	EET768	Cognitive and Software Defined Radio	3
18	EEN725	Advanced Digital Signal Processing	3
19	EEN 824	On-Chip Interconnection Networks	3
20	EEN740	Embedded System Design for Telecommunications	3
21	EEN 825	Optimal sampled - Data Control Systems	3
22	EEN 826	Networked Dynamic Systems	3
23	EEN 725	Advanced Digital Signal Processing	3
24	EEN 728	Real Time DSP Design and Applications	3
25	EEN712	Advanced Digital Communication Systems	3
26	EEN 827	Modern Control Theory	3
27	EEN 828	Advanced Nonlinear Control Systems	3
28	EEP 770	Power Management in Wired and Wireless Systems	3
29	EEP716	Advanced Power Electronics	3
30	EEP 771	Low Power System Design	3
31	EEP 772	Power Awareness in Distributed Systems	3
32	EEP 773	Power System Stability and Dynamics	3
33	EEP 774	Power System Transients	3
34	EEP 775	HVDC and Flexible AC Transmission	3
35	EEP 776	Rural Electrification and Distributed Generation	3
36	EEP 777	Artificial Intelligence Techniques in Power Systems	3
37	EEP 778	Power System Deregulation	3
38	EEP 757	Non-conventional Energy System	3
39	EEP 723	Thermal and Nuclear Power Generation	3
40	EEP714	Advance d Topics in Renewable Energy	3
41	EEP 719	Advanced Topics in Power System Engineering	3
42	EEP720	Computer Methods in Power System	3
43	SEN 723	Formal Methods and Specifications	3
44	SEN 753	Power Aware Computing	3
45	SEN 755	Service Oriented Computing	3
46	CEN 707	Advanced Distributed Systems	3
47	CEN 708	Advanced System Modeling and Simulation	3
48	CEN745	Advanced Digital Image Processing	3
49	CEN 720	Advanced Computer Architecture	3
50	CEN 740	Advanced Embedded System	3
51	CEN 741	ASIC Design Methodology	3
52	CEN 742	Advanced Digital System Design	3
53	CEN 754	MOS VLSI Circuit Design	3
54	CSC 719	Machine Learning	3
55	CSC 750	Advanced Neural Networks	3
56	CSC 759	Agent Based Modeling	3
57	ESC 703	Advanced Qualitative Research Methods	3
58	ESC 704	Advanced Quantitative Research Methods	3
59	ESC716	Advanced Topics in Wireless &Networking	3
60	ESC 701*	Research Methodology	3

*It is mandatory to study ESC 701 Research Methodology, if the scholar has not studied this or equivalent course in MS program.

Allied Engineering Courses

- Students can study maximum two allied/interdisciplinary courses during their PhD (EE) program.
- The choice of allied courses is not limited to the following list and based on PhD Supervisor's recommendation requisite PhD course(s) from SE, CE and CS department can be registered.

61	ESC 705	Critical Review of Literature	3
62	GSC 701	Logic and Research	3
63	CSC 704	Advanced Cryptography	3
64	CSC 711	Advanced Artificial Intelligence	3
65	GSC 700	Advanced Engineering Mathematics	3
66	CEN 708	Advanced System Modelling and Simulation	3
67	SEN 754	Bio Medical Image Analysis	3
68	CSC 751	Pattern Recognition	3
69	CSC 764	Computer Vision	3
70	SEN 745	Data Ware Housing and Mining	3
71	SEN 751	Human Aspects in Software Engineering	3
72		Advanced Web Computing System and Application	3

Appendage1419-PhD-CE

Bahria University
Discovering Knowledge

PhD in Computer Engineering

Department of Computer Engineering

BAHRIA UNIVERSITY

PhD Program (Department of Computer Engineering)

Program Mission

To produce highly skilled scholars with practical and analytical domain knowledge possessing independent & collaborative research expertise in the domain of Computer Engineering.

Objectives

The objectives of PhD program in Computer Engineering are:

4. To produce domain experts with cutting-edge research potential to fill the gap between academia and industry
5. To develop research scholars with exceptional technical writing and result demonstration skills
6. To equip scholars with imperative knowledge, modern tools and techniques to make significant contribution in the field of Computer Engineering by conducting quality research independently or in collaboration.

Program Structure

The PhD program carries 18 hours of course work in the first two semesters. A PhD student is required to pass comprehensive exams and submit a research proposal/synopsis which is to be defended before a panel of experts. The preparation of research proposal and the subsequent stages of supervised research constitute 36 credit hours.

The roadmap of the PhD program along with the curriculum and details of courses are listed in the following:

SEMESTER I		
Course code	**Subject**	**Credits**
	Course Work (Student shall study 3 courses)	9
	Total credits for 1st semester	9

SEMESTER II		
Course code	**Subject**	**Credits**
	Course Work (Student shall study 3 courses)	9
	Total credits for 2nd semester	9

SEMESTER III		
Course code	**Subject**	**Credits**

EEN-901	Comprehensive exam	0
EEN-902	PhD Thesis	9
	Total credits for 3rd semester	**9**

SEMESTER IV		
Course code	**Subject**	**Credits**
EEN-902	PhD Thesis	9
	Total credits for 4th semester	**9**

SEMESTER V		
Course code	**Subject**	**Credits**
EEN-902	PhD Thesis	9
	Total credits for 5th semester	**9**

SEMESTER VI		
Course code	**Subject**	**Credits**
EEN-902	PhD Thesis	9
	Total credits for 6th semester	**9**
	Total credit for the program	**54**

PhD Coursework

- Scholar shall register at least 3 courses from the list of Computer Engineering courses.
- In addition to these courses, PhD scholar will be able to take any course from MSCE, MSEE, MSSE and MSCS with course code 700+. Relevant 700+ courses of MS will be inclusive in category-1 or 2 based on subject area. Supervisor/Advisory committee will decide about the relevance of such courses for each scholar.

Sr. No	Course Code	Title of Course	Credit Hour
Computer Engineering Courses/Category 1			
41	CEN-707	Advanced Distributed Systems	3
42	CEN 708	Advanced System Modelling and Simulation	3
43	CEN 720	Advanced Computer Architecture	3
44	CEN 740	Advanced Embedded Systems	3
45	CEN 741	ASIC Design Methodology	3
46	CEN-742	Advanced Digital System Design	3
47	CEN 745	Advanced Digital Image Processing	3
48	CEN 721	Advance Microprocessor Systems	3
49	CEN 752	Advance VLSI System Design	3
50	CEN 754	MOS VLSI Circuit Design	3
51	CEN 753	Design of Real Time Embedded System Design	3
52	CEN 755	Parallel Processing Computer Systems	3
53	CSC 711	Advanced Artificial Intelligence	3
54	CSC 704	Advanced Cryptography	3
55	CSC 720	Advanced Operating Systems	3
56	CSC 750	Advanced Neural Networks	3
57	CSC 751	Pattern Recognition	3

58	CSC 758	Parallel Processing	3
59	CSC 764	Computer Vision	3
60	CSC 765	Bio Medical Image Analysis	3
61	CSC 781	Cloud Computing	3
62	CSC 719	Machine learning	3
63	EEN 824	On-Chip Interconnection Networks	3
64	EEN 725	Advanced Digital Signal Processing	3
65	EEN 728	Real Time DSP Design and Applications	3
66	EET 716	Advanced Topics in Wireless Networking and Communications	3
67	EET 762	Communication Networks Arch & Protocols	3
68	EET 702	Advanced Network Security	3
69	EET 725	Advanced Routing and Switching	3
70	EET 726	Advanced Internet Technologies	3
71	EET 755	Wireless Communication Techniques	3
72	EET 850	Wireless Sensor Networks	3
73	EET 851	Mobile and ad-hoc Networks	3
74	EET 757	Mobile Computing	3
75	EET 710	Advanced Computer Networks	3
76	EET 726	Advanced Internet Technologies	3
77	EET 702	Advanced Network Security	3

Allied Courses

The scholar can study maximum three allied/interdisciplinary courses during their PhD (CE) program. The choice of allied courses is not limited to the following list and based on PhD Supervisor's recommendation requisite PhD course(s) from SE, EE and CS department can be registered.

Sr. No	Course Code	Title of Course	Credit Hour
Allied Courses			
1	EET 706	Advance Optical Fiber Networks	3
2	EET 711	Advanced Digital Communications	3
3	EET 769	Mobile. Vehicular Ad Hoc Networks	3
4	GSC 700	Advanced Engineering Mathematics	3
5	CSC 746	Advanced Data Mining	3
6	CSC 744	Advanced Computer Graphics	3
7	CSC 760	Advanced Data Warehousing	3
8	EET 766	RF System Engineering and Design	3
9	SEN 754	Advanced Web Computing System and Application	3
10	EET 727	Cognitive Cooperative Networks	3
11	EEP 771	Low Power System Design	3
12	EET 723	Optimization Techniques	3
13	EET 713	Advanced Network Design	3
14	EEN 740	Embedded System Design for Telecommunications	3
15	EET 756	Telecommunication Switching Systems	3
16	SEN 720	Advanced Human Computer Interaction	3

17	SEN 811	Data Ware Housing and Mining	3
18	SEN 762	Advanced Big Data Analytics	3
19	SEN 814	Ubiquitous Computing and Interaction	3
20	CSC 753	Distributed Databases	3
21	SEN 817	Middleware For Networked and Distributed Systems	3
22	CSC 741	Advanced Natural Language Processing	3
23	CEN 708	Advanced System Modeling and Simulation	3
24	CSC 753	Power Aware Computing	3
25	SEN 755	Service Oriented Computing	3
26	SEN 720	Advanced Human Computer Interaction	3
27	ESC-703	Advanced Qualitative Research Methods	3
28	ESC-704	Advanced Quantitative Research Methods	3
29	ESC-705	Critical Review of Literature	3
30	ESC 701*	Research Methodology	3

*It is mandatory to study ESC 701 Research Methodology, if the scholar has not studied this or equivalent course in MS program.

Bahria University
Discovering Knowledge

PhD Computer Science

Department of Computer Sciences

BAHRIA UNIVERSITY

PhD (CS) Program

Program Mission

The mission of the PhD Computer Science program is to prepare individuals to work as independent computing researchers who can take an interdisciplinary approach to solve basic and applied research problems. Students graduating with this degree are prepared for careers as university educators, research scientists or specialized professionals within the field of computing.

Program Objectives

The key objectives of the PhD (CS) program include the following.

1. To prepare scholars to have an understanding of the processes of research which will enable them to independently make original, creative and useful research contributions.
2. To prepare scholars to effectively convey technical contributions through written and oral communication.
3. To enable scholars to carry out research independently as well as in teams.
4. To acquaint scholars with and enable them apply professional code of ethics in research endeavors.

Program Learning Outcomes

Students graduating from the PhD (CS) program are expected to:

1. Critically analyze relevant works and demonstrate creativity and innovation by generating new ideas.
2. Apply the theoretical knowledge and concepts to find answers to research questions.
3. Carry out skilled research, identify, comprehend and synthesize relevant literature, select appropriate techniques and tools to solve the research problem, analyze data produced by experiments and research and, draw meaningful conclusion from the realized results.
4. Demonstrate comprehensive in-depth knowledge of the theory, methods and algorithmic principles in the relevant area of study.
5. Demonstrate leadership qualities through research and other scholarly assignments.
6. Be able to convey research contributions, ideas and arguments in a clear and organized form through technical reports and research publications at reputed publication forums.

Program Structure

The PhD program carries 18 hours of course work in the first two semesters. On of coursework, a PhD student is required to pass the comprehensive exam and submit a

research Proposal/Synopsis which is to be defended before a panel of experts. The preparation of research proposal and the subsequent stages of supervised research constitute 36 credit hours. The findings of the research are to be submitted in the form of thesis for evaluation.

The roadmap of the PhD program along with the curriculum and details on courses are listed in the following.

SEMESTER I		
Course code	**Subject**	**Credits**
	Course Work (Student shall study 3 courses)	9
	Total credits for 1st semester	9

SEMESTER II		
Course code	**Subject**	**Credits**
	Course Work (Student shall study 3 courses)	9
	Total credits for 2nd semester	9

SEMESTER III		
Course code	**Subject**	**Credits**
	Comprehensive exam	0
THS-900	PhD Thesis	9
	Total credits for 3rd semester	**9**

SEMESTER IV		
Course code	**Subject**	**Credits**
THS-900	PhD Thesis	9
	Total credits for 4th semester	**9**

SEMESTER V		
Course code	**Subject**	**Credits**
THS-900	PhD Thesis	9
	Total credits for 5th semester	**9**

SEMESTER VI		
Course code	**Subject**	**Credits**
THS-900	PhD Thesis	9
	Total credits for 6th semester	**9**
	Total credit for the program	**54**

Computer Science Courses

- Student shall register at least 3 courses from the list of Computer Science courses.
- CSC, ISC, DSC courses offered in MS programs at Bahria University with course code 7XX shall be considered as part of Computer Sciences courses for PhD (CS).

S#	Course Code	Title of Course	Cr. Hrs.
(Artificial Intelligence)			
78	CSC 711	Advanced Artificial Intelligence	3
79	CSC-719	Machine Learning	3
80	CSC-741	Advanced Natural Language Processing	3
81	CEN-745	Advanced Digital Image Processing	3
82	CSC 750	Advanced Neural Networks	3
83	CSC-751	Pattern Recognition	3
84	CSC-764	Computer Vision	3
85	CSC 765	Bio Medical Image Analysis	3
86	CSC-750	Intelligent Tutoring Systems	3
87	CSC-715	Intelligent Agents	3
88	CSC 744	Advanced Computer Graphics	3
(Data Science)			
89	DSC-701	Big Data Analytics	3
90	DSC-702	Machine Learning and Data Analysis	3
91	DSC-703	Data Visualization	3
92	DSC-704	Distributed Data Engineering	3
93	DSC-705	Deep Learning and Data Analysis	3
94	DSC-706	Unstructured Data Processing	3
95	CSC-746	Advanced Data Mining	3
96	CSC-747	Text Mining	3
(Networks & Security)			
97	EET-710	Advanced Computer Networks	3
98	EET-702	Advanced Network Security	3
99	EET-713	Advanced Network Design	3
100	EET-716	Advanced Topics in Wireless Networking and Communications	3
101	EET-718	Network Performance Evaluation	3
102	EET-761	Network Protocols and Standards	3
103	EET-705	Broadband Technologies and Components	3
104	EET 726	Advanced Internet Technologies	3
105	EET-850	Wireless Sensor Networks	3
106	EET-851	Mobile and Ad hoc Networks	3
107	ISC-721	Advanced Cryptography and Cryptanalysis	3
108	ISC-731	Information Security Management	3
109	ISC-733	Information Hiding	3
110	ISC-734	Wireless Network Security	3
111	ISC-735	Cloud Computing Security	3
112	ISC-736	Cyber Warfare	3
113	ISC-737	Computer and Network Forensics	3
114	ISC-738	Ethical Hacking	3
115	ISC-739	Cyber Crimes and Laws	3
116	ISC-740	Quantum Cryptography	3
117	ISC-741	Algebraic Cryptanalysis	3

118	ISC-742	Intrusion Detection and Prevention	3
119	ISC-743	Penetration Testing and Vulnerability Analysis	3
(Databases & Web Systems)			
120	CSC-720	Advanced Operating Systems	3
121	CSC 758	Parallel Processing	3
122	CEN 707	Advanced Distributed Systems	3
123	CSC-752	Advanced DBMS	3
124	CSC-753	Distributed Databases	3
125	CSC-754	Object Oriented Databases	3
126	CSC-755	Web based DBMS	3
127	CSC-756	Multimedia Databases	3
128	CSC-760	Advanced Data Warehousing	3
129	CSC-781	Cloud Computing	3
130	SEN 761	Semantic Web	3
131	SEN 764	Ontology Engineering	3
132	CSC-757	IP Multimedia System	3
133	SEN 754	Advanced Web Computing System and Application	3

Allied Courses

Students can study maximum three allied/interdisciplinary courses during their PhD (CS) program.

The choice of allied courses is not limited to the following list and based on PhD Supervisor's recommendation requisite PhD course(s) from SE, CE and EE department can be registered.

134	GSC 700	Advanced Engineering Mathematics	3
135	CEN-720	Advanced Computer Architecture	3
136	CEN 708	Advanced System Modeling and Simulation	3
137	SEN-720	Advanced Human Computer Interaction	3
138	SEN-756	Advanced Usability Engineering	3
139	SEN 723	Formal Methods and Specifications	3
140	SEN 751	Human Aspects in Software Engineering	3
141	SEN 753	Power Aware Computing	3
142	SEN 755	Service Oriented Computing	3
143	SEN 756	Advanced Usability Engineering	3
144	SEN 758	Component-based Software Engineering	3
145	SEN 759	Software Re-Engineering	3
146	SEN 760	Complex Adaptive Systems	3
147	SEN 763	Advanced Software Engineering	3
148	SEN 812	Agile Methods	3
149	SEN 813	Advanced Software Requirements Engineering	3
150	SEN 814	Ubiquitous Computing and Interaction	3
151	SEN 815	Verification and Validation	3
152	SEN 816	Information Retrieval	3
153	SEN 817	Middleware For Networked and Distributed Systems	3
154	EET-703	DSP Application in Telecommunication	3
155	EET-706	Advanced Optical Fiber Networks	3
156	EET-707	Telecommunications Business Environment	3
157	EET-751	Antenna and Microwave Engineering	3
158	EET-756	Telecommunication Switching Systems	3
159	EET-765	Radio Frequency Engineering	3
160	ESC-703	Advanced Qualitative Research Methods	3
161	ESC-704	Advanced Quantitative Research Methods	3
162	ESC-705	Critical Review of Literature	3
163	ESC 701*	Research Methodology	3

*It is mandatory to study ESC 701 Research Methodology, if the student has not studied this or equivalent course in MS program.

Appendage 1423 -BCE Road Map

Bahria University Proposed Roadmap (BCE)

Domain	Knowledge Area	Total Courses	Total Credits	% Overall Cr Hr based
Non-Engineering	Humanities	7	19	30.4%
	Management Sciences	2	6	
	Natural Sciences	5	16	
	Sub Total	**14**	**41**	
Engineering	Computing	3	10	69.6%
	Engineering Foundation	10	33	
	Computer Engg. Core (Breadth)	7	27	
	Computer Engg. Depth Electives	4	12	
	Inter-Disciplinary Breadth (Electives)	2	6	
	Senior Design Project	2	6	
	Internship (Summer)	0	0	
	Sub Total	**28**	**94**	
Grand Total		**42**	**135**	**100%**

Semester No. 1

S. No.	**Course Code**	**Pre-Req**	**Course Title**	**Lec**	**Lab**
1	GSC-110	None	Applied Calculus & Analytical Geometry	3	0
2	ISL-101 /HSS-116	None	Islamic Studies / Ethics	2	0
3	CSC-110	None	Computing Fundamentals	2	1
4	GSC-113	None	Applied Physics	3	1
5	ENG-105	None	Functional English	3	0
6	EEL-112	None	Workshop Practices	0	1
	Total Credit		**16**	13	3

Semester No. 2

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1	GSC-211	GSC-110	Multivariable Calculus	3	0
2	CEN-121	GSC-113	Circuit Analysis	3	1
3	CSC-113	None	Computer Programming	3	1
4	HSS-120	None	Communication Skills	3	0
5	CEN-120	None	Digital Logic Design	3	1
	Total Credit		18	15	3

Semester No. 3

S. No.	**Course Code**	**Pre-Req**	**Course Title**	**Lec**	**Lab**
1	GSC-221	None	Discrete Mathematics	3	0
2	EEN-224	GSC-113	Electronic Devices and Circuits	3	1
3	CSC-210	CSC-113	Object Oriented Programming	3	1
4	PAK-101	None	Pakistan Studies	2	0
5	GSC-210	GSC-110	Differential Equations	3	0
6	EEL-121	None	Engineering Drawing & CAD	0	1
	Total Credit		17	14	3

Semester No. 4

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1	GSC-121	None	Linear Algebra	3	0
2	CSC-221	CSC-210	Data Structures and Algorithms	3	1
3			GE/Management Elective-1	3	0
4	EEN-313	GSC-220	Signals & Systems	3	1
5	CEN-221	CEN-120	Computer Architecture and Organization	3	1
	Total Credit		18	15	3

Semester No. 5

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1	EEN-226	None	Probability Methods in Engineering	3	0
2	CEN-321	CEN-221	Microprocessors and Interfacing	3	1
3	CEN-222	None	Data Communication & Networking	3	1
4	None	CSC-210	Database Management Systems	3	1
5	HSS-320	None	Technical Writing and Presentation Skills	3	0
	Total Credit		**18**	15	3

Semester No. 6

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1	EEN-325	EEN-313	Digital Signal Processing	3	1
2	SEN-220	CSC-221	Software Engineering	3	0
3	CSC-320	CEN-221	Operating Systems	3	1
4			CE-Depth Elective –I	2	1
5	CEN-442	CEN-221	Digital System Design	3	1
	Total Credit		**18**	14	4

Semester No. 7

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1			IDEE Elective-I	2	1
2	HSS-422	None	Engineering Ethics	3	0
3			CE Depth Elective-II	3	0
4			CE Depth Elective-III	2	1
5			**Project -1**	0	3
	Total Credit		**15**	10	5

Semester No. 8

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1			GE/Management Elective-II	3	0
2			IDEE Elective-II	3	0
3			CE Depth Elective –IV	2	1
			GE/Social Science Elective	3	0
5			**Project-2**	0	3
	Total Credit		**15**	11	4

Total Credit Hours = 135

IDEE COURSES

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1	CEN-468	CEN-222	Introduction to Communication Systems	2	1
2	CEN-438	CEN-120	Fault Tolerant Systems	2	1
3	CEN-463	EEN-313	Robotics	2	1
4	CEN-449	CSC-320	System Programming	2	1
5	CSC-444	None	Computer graphics	2	1
6	SEN-493	None	Multimedia Systems	2	1
7	CSC-449	CSC-411	Neural Networks and Fuzzy Logic	3	0
8	CSC-321	CSC-221	Design Analysis of Algorithms	3	0
9	EEN-466	None	Nanotechnology	3	0
10	EEN-467	EEN-313	Control Engineering	3	0
11	SEN-320	None	Human Computer Interaction	3	0
12	SEN-452	None	Cloud Computing	3	0
13	SEN-332	None	Big Data Analytics	3	0
14	ENV-105	None	Introduction to Environmental Sciences	3	0
5	ENV-425	None	Occupational Health and Safety	3	0

CE Depth Elective Courses (15 Credit Hours)

S. No.	Course Code	Pre-Req	Course Title	Lec	Lab
1	SEN-448	None	Software Applications for Mobile Devices	2	1
2	CSC-411	None	Artificial Intelligence	2	1
3	CEN-470	CEN-222	Wireless and Mobile Networks	2	1
4	CEN-445	EEN-313	Digital Image Processing	2	1
5	CSC-455	None	Data Mining and Warehousing	2	1
6	CEN-456	CSC-320	Parallel & Distributed Computing	2	1
7	CEN-439	CEN-321	Embedded System Design	2	1
8	CEN-446	CEN-120	FPGA Based System Design	2	1
9	CEN-457	CEN-120	VLSI Design	2	1
10	CEN-459	CSC-320	Real Time Systems	2	1
11	GSC-320	GSC-210	Numerical Analysis	3	0

12	SEN-410	SEN-220	Software Project Management	3	0
13	SEN-420	None	Software Quality Assurance	3	0
14	CEN-451	None	Data Encryption and Security	3	0

List of General Electives					
Pre-Req	**Course Code**	**Course Title**	**Total Credit Hours**	**Theory**	**Lab**
None	HSS-202	Introduction to Sociology	3	3	0
None	PSY-101	Introduction to Psychology	3	3	0
None	HSS-111	Introduction to International Relations	3	3	0
None	HSS-459	Foreign Language (Arabic, French etc.)	3	3	0
None	MGT-111	Principles of Management	3	3	0
None	HSS-453	Human Resource Management	3	3	0
None	HSS-411	Engineering Economics & Mgmt.	3	3	0
None	HSS-461	Accounting & Finance	3	3	0
None	HSS-456	Organizational Behavior	3	3	0
None	HSS-115	Introduction to Media Studies	3	3	0
None	HSS-201	Introduction to Anthropology	3	3	0
None	HSS-421	Entrepreneurship & Leadership	3	3	0

Course Title: **WORKSHOP PRACTICES**

Course Code: **EEL-112**

Credit Hours: **0 (Theory) + 1 (Lab)**

Prerequisites None

Objectives: To develop practical skills in the use of workshop tools and equipment.

Lab Work Outline:

Hands on practice on these related concepts:

Introduction to various technical facilities in the workshop including mechanical and electrical equipment. Concepts in electrical safety, safety regulations, earthing concepts, electric shocks and treatment. Use of tools used by electricians, wiring regulations, types of cables and electric accessories including switches, plugs, circuit breakers, fuses etc., symbols for electrical wiring schematics e.g. switches, lamps, sockets etc., drawing and practice in simple house wring and testing methods, wiring schemes of two-way and three-way circuits and ringing circuits, voltage and current measurements. Electric soldering and soldering tools; soldering methods and skills, PCB designing, transferring a circuit to PCB, etching, drilling and soldering component on PCB testing.

Recommended Books

1. Choudhury, "Elements of Workshop Technology", Vol. 1, MPP.
2. Chapman, "Workshop Technology", Part-I,II,III, CBS.

Course Title: **APPLIED CALCULUS AND ANALYTICAL GEOMETRY**

Course Code: **GSC-110**

Credit Hours: **3 (Theory) + 0 (Lab)**

Prerequisites **None**

Objective

Teach the concepts of calculus and analytic geometry and the applications of these concepts to the solution of engineering problems.

Course Outline

Complex Numbers, DeMoivre's Theorem and its Applications, Simple Cartesian Curves, Functions and Graphs, Symmetrical Properties, Curve Tracing, Limit and Continuity, Differentiation of Functions. Derivative as Slope of Tangent to a Curve and as Rate of Change, Application to Tangent and Normal, Linearization, Maxima/Minima and Point of Inflexion, Taylor and Maclaurin Expansions and their convergence. Integral as Anti-derivative, Indefinite Integration of Simple Functions, Methods of Integration: Integration by Substitution, by Parts, and by Partial Fractions, Definite Integral as Limit of a Sum, Application to Area, Arc Length, Volume and Surface of Revolution.

Recommended Books

1. George B. Thomas and Ross L. Finney, "Calculus and Analytic Geometry," Addison-Wesley, Latest Edition
2. George F. Simmons, "Calculus with Analytic Geometry," Latest Edition, McGraw-Hill,
3. Gerald B. Folland, "Advanced Calculus," Latest Edition, Prentice Hall
4. Monty J. Strauss, Gerald L. Bradley and Karl J. Smith, "Calculus", Latest Edition, Prentice Hall

Course Title: **MULTIVARIABLE CALCULUS**

Course Code: **GSC-211**

Credit Hours: **3 (Theory) + 0 (Lab)**

Prerequisites Calculus and Analytical Geometry

Objective

The goals are to develop the skills to have ground knowledge of multivariate calculus and appreciation for their further Engineering courses.

Course Outline:

Functions of Several Variables and Partial Differentiation. Multiple Integrals, spherical, cylindrical coordinates, vector fields, gradients, line and surface integrals. Green's and Stoke's Theorem.

Recommended Books

1. "Multivariable Calculus: Early Transcendentals", (Stewart's Calculus Series), Latest Edition.
2. Swokowski, Olinick and Pence, "Calculus and Analytical Geometry", Latest Edition, Thomson Learning EMEA, Ltd.
3. William Briggs, Lyle Cochran, Bernard Gillett, "Multivariable Calculus" 2010, Pearson Education.
4. Howard Anton, Albert Herr, "Multivariable Calculus", Latest Edition, John Wiley.

Course Title: **CIRCUIT ANALYSIS**

Course Code: **CEN-121**

Credit Hours **3 (Theory) + 1 (Lab)**

Pre-requisites **Applied Physics (GSC-113)**

Objectives

To introduce transient and steady state analysis of DC and AC circuits

ESSENTIAL TOPICS TO BE COVERED

- Elementary Transient Analysis
- Sinusoidal State Analysis
- Exponential Excitation and the Transformed Network

Course Outline:

Differential and integral forms of circuit equations, consideration of initial conditions, analysis of first and second order circuits, network response to sinusoidal driving functions, concept of phasors, power consideration and complex power. Series and parallel RC, RL and RLC circuits. AC fundamentals; nodal analysis, loop analysis, linearity and superposition, source transformation, circuit theorems

Lab Work Outline:

Hands on practice on related concepts covered in theory.

Recommended Books:

1. Electric circuits by James W Nilsson & Susan A Riedel, 8th Edition, Addison-Wesley, or Latest Edition.
2. S. Franco, "Electric Circuits Fundamentals", Oxford University Press, Latest Edition
3. W. Hayt, J. Kemmerly and S. Durbin, "Engineering Circuit Analysis", McGraw-Hill, 8th Edition, 2011,

Course Title: **ELECTRONIC DEVICES AND CIRCUITS**

Course Code: **EEN-224**

Credit Hours **3 (Theory) + 1 (Lab)**

Pre-requisites **Applied Physics (GSC-113)**

Objectives:

To introduce large signal analysis and design of diode circuits and transistor based amplifiers.

ESSENTIAL TOPICS TO BE COVERED

- Diode circuit analysis and applications
- Biasing of BJT amplifier.
- Biasing of FET amplifier.
- Modeling of amplifiers.
- Operational amplifier application.

Course Outline:

PN junction diodes, Forward and reverse characteristics of diode, Ideal diode, Practical diode, Equivalent circuits of diode, current equation of diode, diode as a switch. Schottky diode, Zener diode, Tunnel diode, Varactor diode. LED, Laser diode and their applications. Bipolar junction transistor Operation (NPN and PNP), DC circuit analysis, Load line BJT biasing, bias stability. Design and analysis of common emitter, common base and common collector amplifiers. FET biasing, design of common source, common drain and common gate amplifiers. Hybrid parameters, ac gain and frequency analysis of single/multi stage amplifiers. Classes of amplifiers, power amplifiers, differential amplifiers, operational amplifiers and applications.

Lab Work Outline:

Hands on practice on related concepts covered in theory.

Recommendation Books:

1. Robert Boylestad and Louis Nashelsky, “Electronic Devices and Circuit Theory” , Prentice Hall, 11th Edition or Latest Edition
2. Thomas L. Floyd, “Electronic Devices”, Latest Edition
3. V.K. Mehta “Principles of Electronics ", Latest Edition
4. Malvino “Electronic Principles”, Latest Edition

Course Title: **ENGINEERING DRAWING & CAD**

Course Code: **EEL-121**

Credit Hours: **0 (Theory) + 1 (Lab)**

Prerequisites None

Objective:

To equip the students with the basic knowledge and skills of engineering drawing and its application in practical scenarios. The students will also be introduced to a CAD package.

Course Outline:

Types of lines and usage, dimensioning, lettering, orthographic first angle projection, sheet planning, orthographic third angle projection, introduction to computer aided drawing, isometric projection, sectional drawing and assembly drawing. Drawing sheets will be prepared on drawing board as well as CAD package.

Recommended Books:

1. Shawna Lockhart, “Tutorial Guide to AutoCAD”, Prentice Hall.
2. A. C. Parkinson, "First Year Engineering Drawing".

Course Title: **PROBABILITY METHODS IN ENGINEERING**

Course Code: **EEN-226**

Credit Hours: **3 (Theory) +0 (Lab)**

Prerequisites: **Applied Calculus and Analytical Geometry (GSC-110)**

Objective: To introduce the basic concepts and engineering applications of probability and statistics.

Course Outline:

Set theory, basic concepts of probability, conditional probability, independent events, Baye's Theorem, discrete and continuous random variables, distributions and density functions, probability distributions (binomial, Poisson, hyper geometric, normal, uniform and exponential), mean, variance, standard deviations, moments and moment generating functions, linear regression and curve fitting, limits theorems and applications.

Recommended Books:

1. A. Leon-Garcia, "Probability and Random Processes For Electrical Engineering", Pearson Education, 2nd Edition, 1994.
2. Sheldon Ross, "A First Course in Probability", Pearson Education, 6th Edition, 2002.

Course Title: **WIRELESS AND MOBILE NETWORKS**

Course Code: **CEN-470**

Credit Hours **2 (Theory) + 1 (Lab)**

Pre-requisites **Data Communication and Networking (CEN-222)**

COURSE DESCRIPTION

Introduction to Wireless Communication, Wired vs. Wireless Communication, Electromagnetic Spectrum, Design Challenges, Wireless Transmission, Evolution of Wireless Networks , 1G Cellular Networks, 2G Cellular Networks, 2.5G Cellular Networks, 3G Cellular Networks, Limitation of 3G, 4G Objectives, Issues, QoS, Security, Multimedia Services and Applications, Tariff management, WLANS(IEEE802.11), WiMAX (IEEE802.16), Wireless PAN(IEEE802.15)), Fundamentals of Cellular Concepts(Cellular Concept, AMPS Architecture, Frequency Reuse, Locating co-channel cells, Channel Assignment Strategies, Handoff Strategies, Prioritizing Handoff, Practical Handoff Considerations, Co-channel Interference and Capacity, Adjacent Channel Interference and Capacity, Channel Planning for Wireless System, Trunking and Grade of Service, Measuring Traffic Intensity, Trunked Systems, Erlang Charts, Improving Coverage and Capacity, Cell Splitting, Sectoring, Repeaters for Range Extension, Microcell Zone Concept), Analog Mobile Phone System (Introduction, Architecture, System Overview, Call Handling, Air Interface, Supervisory Signals, N-AMPS), GSM Specifications, Identifiers in GSM Network, Call Routing in GSM, GPRS, EDGE, CDMA One / IS-95, Mobile Wireless CDMA Design Considerations, Walsh Codes, IS-95 Reverse Link, EDGE, WCDMA / UMTS, Logical Channels in WCDMA, Spreading and Scrambling, Transport and Physical Channels, Signaling, Physical Layer Procedures, Compressed Mode Measurements, Handover Measurements, WCDMA , CDMA 2000 Mobile Ad Hoc, 802.11 Security, WEP Protocol, EDCF, HCF, Mobile IP, Introduction to Wireless Mesh Networks, Characteristics, MANET, WSN, High Rate WPAN , ZigBee, WiMax/IEEE 802.16, OFDM, OFDMA, 4G Overview, Issues, Mobility Management, Handoff types, QoS Considerations

Recommended Books

1. Jochen Schiller, “Mobile Communications”, Pearson Education, 2004or Latest Edition.

References

1. Handbook of Wireless Networks and Mobile Computing, Edited by Ivan Stojmenovic, John Wiley & Sons, Inc., 2002or Latest Edition.
2. Aftab Ahmad , “Wireless and Mobile Data Networks”, John Wiley & Sons, 2005or Latest Edition.
3. W. Stallings, “Wireless Communications and Networks”, Prentice Hall, 2002or Latest Edition.
4. K. Pahlavan& P Krishnamurthy, “Principles of Wireless Networks”, Prentice Hall, 2002or Latest Ed.
5. K. Daniel Wong, “Wireless Internet Telecommunications”, Artech House, Inc 2005, or Latest Edition.
6. Yi-Bang Lin, “Wireless and Mobile Network Architectures”, John Wiley & Sons, 2001 or Latest Ed.

Course Title: **SOFTWARE QUALITY ASSURANCE**

Course Code: **SEN-420**

Credit Hours **3 (Theory) + 0 (Lab)**

Pre-requisite **None**

Objectives

Develop a good quality assurance plan and standards for large, small and fast-track projects and Understanding of how to use quality management tools effectively.

Course Outline

Introduction to software quality assurance, Fundamentals of software quality assurance practice, Software quality control processes, Software quality verification, Software quality measurement, Supporting tools for software quality control, The SEI Capability Maturity Model for Software, ISO 9000 for Software, Software Testing Techniques, Software Testing Strategies, Formal Methods, Software quality certification, Deploying a quality system.

Recommended Books

1. Jerry ZeyuGao, H. S. Jacob Tsao, and Ye Wu, Testing and Quality Assurance for Component-Based Software, Artech House Publishers, 2003 or Latest Edition.
2. Frank P. Ginac, Customer Oriented Software Quality Assurance, Prentice Hall PTR; Latest Edition