

**Minutes
of the
19th Meeting of the Board of Studies
Faculty of Engineering Sciences
held on
6th & 28th August, 2019
through VLC**



Bahria University Islamabad

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Minutes of the 19th Meeting of the Faculty Board of Studies Engineering Sciences held on August 06 & 28 , 2019 by VLC

Attendance:

BUIC

Present

- | | | |
|--|------------------|--------|
| • Prof. Dr. Muhammad Najam ul Islam | Dean ES | Chair |
| • Prof. Dr. Tahseen Ullah Khan | HOD(E&ES) | Member |
| • Prof. Dr. Atif Raza Jafri | HOD(EES) | Member |
| • Senior Associate Prof. Dr. Muhammad Muzammil | HOD(CS) | Member |
| • Senior Assistant Prof. Dr. Khalid Javed | HOD(CE) | Member |
| • Senior Associate Prof. Engr. Bilal Ashraf Awan | (Acting) HOD(SE) | Member |

BUKC

Present

- | | | |
|--|----------------------------|--------|
| • Senior Prof. Dr. Mehrab Khan | Representing
HOD (E&ES) | Member |
| • Senior Assistant Prof. Dr. Syed safdar ali | HOD(CS) | Member |
| • Associate Prof. Dr. Sohaib Ahmed | HOD(SE) | Member |
| • Senior Asstt. Prof. Dr. Rizwan Iqbal | HOD(CE) | Member |
| • Prof. Dr. Haroon Rasheed | HOD(EES) | Member |

BULC

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

Proceedings

Preliminaries

FBoS-ES meeting took place on two days; in first session, with the quorum complete, the proceedings commenced at 1000 hrs, with recitation from the Holy Quran on 6th August, 2019.

The second session of FBoS took place on 28th August, 2019, with the quorum complete; the proceedings commenced at 1015 hrs.

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

New Items:

Item 1901: Revision in KPIs order for PEOs of BEE Program.

Sponsor: HOD(EE)BUKC

Referral Authority: DBoS EE BUKC

Summary of the Case

In reference to the observations made by PEC, EE Dept. BUKC in consultation with EE Dept. BUIC has amended the order of PEOs. Following are the KPIs order revised with new order of PEOs.

PEO 1:

- 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.

PEO 2:

- 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.

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.

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.

Discussion

The sponsor presented and reiterated the agenda point, after detailed discussion and deliberation the house suggested few changes which were incorporated.

Decision 1901

Revised KPIs order for PEOs of BEE Program approved.

Item 1902: Revision of PEOs for BEE program

Sponsor: HOD(EE)BUKC

Referral Authority: DBOS EE BUKC

Summary of the Case

In reference to the observations made by PEC, EE Dept. BUKC amended the PEOs under the Guidelines of PEC. The revisions in PEOs are discussed. Suggestions from CAC members regarding PEOs and their mapping to PLOs were also discussed. The order of PEOs was also discussed in accordance with PEC observations.

Discussion

The sponsor while presenting the agenda point stated that in reference to the observations made by PEC, EE-KC amended the PEOs in consultation with EE-IC. Revised PEOs were deliberated by house in length. With minor changes, the recommendations were approved in line with PEC guidelines.

Decision 1902

Revised PEOs for BEE ([appendage 1902](#)) recommended for approval in ACM.

Item 1903: BEE curriculum updating to meet the needs of Industry 4.0 revolution

Sponsor: HOD (EE)BUKC

Referral Authority: DBOS EE BUKC

Summary of the Case

In order to minimize the gap between industry and academia it is essential to align curriculum according to the current industry needs. Therefore, interdisciplinary courses attached at Appendage 1904 are proposed to be added to BEE curriculum.

Discussion:

Importance of interdisciplinary courses with their course outlines were presented by the sponsor. He further added that dynamics of industry are changing; laying a premium on relevant new elective courses for students of engineering & computing specializations. The chair suggested ensuring updated course codes for the courses in course outlines.

Course outlines with updated course codes were submitted again by the sponsor.

Decision 1903:

The course outlines attached ([appendage 1903](#)) forwarded to ACM for approval.

Item 1904: Correction of courses being offered in 4th, 5th and 6th semester in road map of BEE program

Sponsor: HOD(EE)BUKIC

Referral Authority: DBOS EE BUKC

Summary of the Case

BEE roadmap was revised in 17th FBOS meeting to incorporate the recommendation of new revised curriculum by HEC published in 2018. The following points are of concerned:

- It is observed that the stream specific courses are now being offered at 6th semester which is considerable late for the student to apply the particular knowledge in their FYP.
- Students have extra load of core courses in last three semesters.

Following changes are recommended for approval:

1. Electrical Machine course (3+1) in 4th semester.
2. Probability Methods in Engineering (3+0) in 5th Semesters.
3. Breadth Core-1(3+1) in 5th Semester.
4. Embedded System (3+1) in 6th Semester.

Discussion

HoD EE-BUKC presented the agenda point, after detailed discussion and deliberation the chair asked Engr. Faraz Humayun to work more on the agenda point and present again.

Decision 1904

Point dropped.

Item 1905: Criteria for selection of Power, Electronics and Telecom streams

Sponsor: HOD (EE) BUKC

Referral Authority: DBOS EE BUKC

Summary of the Case

Since there are three specialization streams offered in BEE program at BUKC therefore there should be some selection criteria among the three major streams (Power, Electronics and Telecom) of Electrical Engineering Program in BUKC. So that realistic strength in all the three streams may be maintained.

Recommendations:**a) For Batch 2017 to 2018**

- i. It is suggested that EE department will select the power stream students among the existing strength of 4th semester students.
- ii. Therefore, No. of seats for Power stream will be 40% of the total number of students promoted to 5th semester.
- iii. All students of 5th semester will be asked to fill a domain/stream selection consent form.
- iv. If the number of student exceeds the allowable 40% seats, then selection will be based upon CGPA.
- v. In case of same CGPA, the selection will be based on the GPA of foundation (Electrical / Electronics) courses which students have studied during past four semesters.
- vi. Remaining students will be free to choose among Electronics and Telecommunication streams.

b) For Batch 2019 and onwards

- i. It is mentioned that an additional field of Power stream will be added in the BUKC admission form so that students may select their preferred stream at the time of admission.

The Proposed Consent form is attached as [Appendage 1905](#).

Discussion

The sponsor presented and reiterated the agenda point which deliberated in detail by house. HoD CS-BUIC suggested that rather than guiding students to adopt stream we should train our faculty for courses in demand. The chair added that department cannot force or stop students from acquiring specific stream. The house agreed with the chair.

Decision 1905

Point dropped

Item 1906: Departmental OBE software approval for CLO and PLO analysis for CQI process

Sponsor: HOD(EE) BUKC

Referral Authority: DBOS EE BUKC

Summary of the Case

There is a need of software for detailed CQI analysis for PLOs and CLOs. Therefore, EE BUKC has developed a software “Smart OBE” for this purpose and testing of this software is in progress since fall 2018 semester. The software is compatible with present needs of OBE.

Discussion

HoD EE-BUKC presented the agenda point; the chair commented that as per University decision OBE portal will be unique. He further added that OBE coordinator Dr. Raja Salman might be leaving for postdoctoral next month. Moreover, he suggested HoD EE-BUKC to discuss agenda point with HoD EE-BUIC and OBE coordinator to incorporate suggestions.

In second session of FBOS, the sponsor presented his suggestions to the house in presence of Dr. Raja M. Suleman and newly appointed OBE coordinator Mr. Adeel M.Syed.

Decision 1906

The chair directed HoD EE BUKC to shift on OBE module with immediate effect. Moreover, HoD EE BUKC & BUIC were advised to work in close collaboration with OBE software team.

Item 1907: Analysis of low intake and student dropout ration in EE department

Sponsor: HOD(EE) BUKC

Referral Authority: DBOS EE BUKC

Summary of the Case

The BEE department has done some analysis on low intake and Student dropout ratio. It was observed that dropout ration is around 50%. The following reasons have been identified:

- Strict policy of chance and dropout considering the quality of intake.
- Admission is done before Final result of intermediate exam that's why a large number of students are unable to apply to BUKC.
- Students are generally very weak in Applied Sciences.

It was also discussed that solutions of these identified issues may be resolved. The detailed analysis regarding challenges to the BEE program is attached as [Appendage 1907](#). It is recommended to adopt NED policy to avoid low intake and dropout ratio.

Discussion

The Sponsor reiterated the agenda point, house agreed with the findings. Moreover, same situation happens in other departments in different courses. After deliberation and arguments house suggested revising policy and mechanism for drop, probation and course registration. The chair suggested HoD EE-BUKC to prepare a consolidated document in consultation with HoD CE-BUIC and HoD CS-BUIC.

Decision 1907

HoD EE-BUKC is to submit consolidated document till 30th September 2019.

Item 1908: MSCE admission eligibility criteria review

Sponsor: HOD(CE) BUIC

Referral Authority: DBOS CE BUIC

Summary of the Case

A committee comprising of the following members was constituted by HoD CE BUIC to align the roadmap/curriculum of the MSCE program in accordance with the latest HEC guidelines issued during their last visit:

- Engr. Dr. Shehzad Khalid
- Engr. Dr. Amina Jameel
- Engr. Dr. Shahzad Hasaan
- Engr. Dr. Usman Akram (External)

Discussion

HOD CE BUIC presented and iterated the case. The agenda item was deliberated in length in FBoS and house recommended to discuss agenda item in DBOS of CE BUKC and prepare consolidated roadmap. The revised roadmap duly endorsed by both departments of Computer Engineering at BU was approved by the house.

Decision 1908

The attached Revised MSCE roadmap ([Appendage 1908](#)) forwarded to ACM for approval.

Item 1909: PLO performance equation based on intensity matrix

Sponsor: HOD(SE) BUKC

Referral Authority: DBOS SE BUKC

Summary of the Case

During PEC Visit, it was discussed by the PEC visitation team that the intensity matrix has no impact in the assessment process. HoD(SE), KC mentioned that the PLO performance equation based on intensity matrix has been approved at DBOS level. However, for the last visit, the department has not used this equation for the analysis as it was not approved at faculty level. Therefore, it is required to discuss this equation at faculty level for further deliberation.

At department level, it has been discussed that all PLO having equal impact is not practical as different PLOs have different intensity number of credit hours should also be considered in our KPI.

The equation devised for assessing the PLO performance is as given below in Equation 1:

$$PLO = \frac{\sum(CLO \times CH \times Emphasis)}{\sum(CH \times Emphasis)} \quad (1)$$

Where,

CLO: score of CLO from a given course related to the PLO under consideration.

CH: number of credit hours of the course for which the CLO is considered.

Emphasis: the emphasis level assigned to the PLO in the given course taken from the “Courses to PLOs” mapping table.

For the sake of utilizing the PLO emphasis levels defined in the PEC accreditation manual effectively within the PLO assessment formula, given by Equation 1, these emphasis levels are used in reverse when applied in the formula. Hence, the mapping given in Table 4 is adopted for the PLO emphasis level when applied in Equation 1.

Table 1: PLO Emphasis Levels Mapping.

PLO Emphasis Levels (PEC Manual)	PLO Emphasis Levels (In Equation)
1 = High	1 = Low
2 = Medium	2 = Medium
3 = Low	3 = High

The house discussed the equation and found it very practical as courses having more credit hours and CLOs / PLOs having more intensity should carry more weight in PLO assessment.

Discussion

The sponsor reiterated the agenda point and supported his argument by presenting the analysis of weighted PLO assessment. The house appreciated the effort and suggested to have more analysis of PLO at departmental level. The chair suggested HoD SE, BUKC to discuss agenda point with HoD SE, BUIC having OBE coordinator on board and present again.

Decision 1909

HoD SE-BUKC presented agenda point again in second half. The house recommended adding PLO performance equation as an optional module in OBE software in due course of time.

Item 1910: BS (CS/IT) Final Year Project (FYP) Procedures and Workflow

Sponsor: HOD(CS) BULC

Referral Authority: DBOS CS BULC

Summary of the Case

Following recommendations were tabled by the HoD CS, BULC:

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1. FYP procedures and workflow be approved for uniform execution of this academic activity for the undergraduate programs of the University related to Computer Science and Information Technology.
2. There should be an FYP portal for the submission of FYP milestones (Proposal, Doc1, Doc2, Final Doc & Product, and Revised Doc & Product), announcements/reminders to the FYP students, supervisor and Examiners.
3. List of students completing their 80 credit hours be available to the FYP Coordinator after declaration of the result of 6th semester.
4. The university should provide official email address for each student for all sorts of official correspondence including correspondence with the FYP Office.
5. The result of P-I should be included for the purpose of provisional CGPA to realistically measure the effort of the dropout cases at the end of 7th semester.

Discussion

The sponsor presented the agenda point which was deliberated in length by the house. After detailed discussion the chair constituted following committee to prepare separate and consolidated FYP workflows for Computing and Engineering, he further added that work flows must be aligned with PEC and NCEAC guidelines.

1. HoD-SE-BUKC, Chair
2. FYP Coordinators-EE, SE & CE at BUKC & BUIC
3. FYP Coordinators- CS at BUIC, BUKC & BULC

Decision 1910

The committee is to prepare and send report in one month.

Item 1911: Addition of BEE courses (Electives).

Sponsor: HOD(EE) BUIC

Referral Authority: DBOS EE BUIC

Summary of the Case

To be more aligned with HEC curriculum and to be at par with current technology advancements it was suggested that some courses should be added to the Electives of the BEE program. The courses suggested were as follows:

- IoT and AI
- Introduction to Renewable Energy
- HVAC
- Information Security

Information security course already exists in CS (Course Code: CSC 407) with credit: 3+0, it is proposed to approve this course as IDEE in BEE Roadmap. Course outlines are attached at [appendage 1911](#).

Discussion

The sponsor reiterated the agenda point: HoD SE emphasized for having pre requisite of Information Security in BEE roadmap while HoD EE, BUKC suggested having IoT and AI as separate courses at undergraduate level in EE program.

The chair suggested revising and aligning of the agenda point as per discussion in FBoS. He further advised to prepare agenda point again in consultation with HoD EE, BUKC and present in next FBoS.

Decision 1911

Point dropped.

Item 1912: MSEE Road Map Update

Sponsor: HOD(EE) BUIC

Referral Authority: DBOS EE BUIC

Summary of the Case

To make MSEE program more attractive for R&D organizations, it was suggested to propose addition of Systems Engineering specialization stream. In the age of advancement and technology, the students should be offered more courses related to their domain, for this purpose it was proposed to offer Research Methodology as a mandatory non-credited, 2 hours course and RM shall be completed

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before proposal defense for MSEE students with Thesis option. Advanced Simulation & Modeling (CSC-708) is proposed to be offered as university requirement course for MSEE students. The proposed roadmap for Systems Engineering specialization stream is attached at [appendage 1912](#).

Discussion

HoD EE, BUIC presented the agenda point, which was deliberated in length by the house. The sponsor supported the agenda point by stating that there are some organizations in Pakistan which requires individuals with knowledge of control, communications and embedded systems. Launching of multidisciplinary stream can attract individuals from such organizations. However, HoD CE and SE, BUIC pointed out that core courses of system engineering along with other important courses are missing in roadmap. HoD EE, BUKC suggested to discuss and revise the agenda point again on email thread.

The sponsor, in his remarks said that the case is not well prepared, it is highly desirable to prepare the case under well thought process and present again.

Decision 1913

Point dropped.

Item 1914: Honorarium revision for FYPs

Sponsor: HOD(EE) BUIC

Referral Authority: DBOS EE BUIC

Summary of the Case

In 12th ACM held on June 2009 the project supervision honorarium was revised from 4000 to 8000. The honorarium may please be increased to 20000 as 2 to 3 students of BEE are supervised at the same time during two semesters whereas university charges 6 credit hour fee per student. Moreover, for MS supervision it is 15000 per student during two semesters.

Discussion

The sponsor presented and iterated the case. After detailed discussion and arguments, board unanimously recommended the agenda point for ACM. However, the chair FBoS suggested that it would be more effective if we move case on file. The Board agrees with chair suggestion.

Decision 1914

HoD EE , BUIC is to formulate the case and process on file through Dean ES.

Item 1915: Revision of Roadmap - MS Telecom and Networks (TN) Program

Sponsor: HOD(CS) BUIC

Referral Authority: DBOS CS BUIC

Summary of the Case

MS TN program requires roadmap revision, and eligibility criteria for the program also need to be defined. Following committee was constituted by HoD CS to revise the roadmap for the MS TN program in accordance with the HEC guidelines.

- a. Dr. Moneeb Gohar (Head)
- b. Prof. Dr. Faisal Bashir -- Member
- c. Dr. Kashif Naseer – Member

The committee revised the existing curriculum, eligibility criteria and presented revised road map of the MS TN program. The roadmap of MS TN Program was revised and is recommended for approval.

Discussion

The revised road map of MS(T&N) program was presented in FBoS-ES, which was deliberated in length, with minor changes revised roadmap attached at [appendage 1915](#) was recommended to be forwarded to ACM for approval.

Decision 1915

The agenda item is recommended for consideration of ACM.

Item 1916: Certificates for Rector Honor List

Sponsor: HoD(EE) BUIC

Referral Authority: DBOS EE BUIC

Summary of the Case

To appreciate the efforts of the student's efforts in academics who achieve good CGPA and therefore appear in Rector's Honor List, HOD(EE) suggested that such students be awarded with certificates.

Discussion

The sponsor reiterated the case; after detailed discussion and deliberation house agreed to the suggestion presented by the sponsor.

Decision 1916

The chair directed faculty coordinator to prepare comprehensive document and move case on file through Dean ES.

Item 1917: Comprehensive result analysis

Sponsor: All HoDs

Referral Authority: FoES

Summary of the Case

Apropos decision 32 para 'c' of item No. 3137 of minutes of the meeting of 32nd ACM, comprehensive result analysis shall be undertaken by each department for corrective action plan and shall be tabled at FBoS.

Discussion

Following departments presented comprehensive result analysis report:

1. CE, BUIC
2. CE, BUKC
3. CS, BUKC
4. SE, BUKC

However, following departments comprehensive result analysis was not in the desired format:

1. CE, BUKC
2. CS, BUKC
3. SE, BUKC

Decision 1917

The chair FBoS asked departments to submit comprehensive result analysis report again in the desired format.

Item 1918: Suggestion for students' facilitation

Sponsor: Dean ES

Referral Authority:

Summary of the Case

The Dean ES directed Engineering Sciences departments to discuss affairs related to course registration, examination, admission, student counseling, SSC etc in their respective DBoSs and present suggestions regarding students' facilitation in FBoS.

Discussion

Suggestions presented by each department were deliberated in length in FBoS.

Decision 1918

The chair FBoS asked HoD CS, BULC to get input from all departments of Engineering Sciences through email regarding CMS portal issues and student facilitations and prepare a consolidated document.

Item 1919: Revision and documentation required of goals/objectives to align with university vision and mission for Computer Science Program

Sponsor: HoD(CS) BUKC

Referral Authority: DBOS CS BUKC

Summary of the Case

The NCEAC team visited department on 14th January, 2019, during the visit NCEAC team directed department to align objectives of program with mission and vision of University with proper documentation.

Discussion

The Dean ES suggested department to discuss the agenda point in their DBoS and recommend revised objectives in consultation with CS-BUIC & CS-BULC.

Revise objectives of program and mission and vision of BS(CS) & BS (IT) are attached at [appendage 1919](#).

Decision 1919

Agenda point approved.

Closing of the Meeting

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



Prof. Dr. M. Najam-ul-Islam

Dean (ES), Head FBoS

06 September, 2019

Distribution:

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

Appendages:

Appendage 1902

Revised PEOs and PLO to PEO mapping of BEE Program

University Vision

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

University Mission

To attain highest standards in teaching, learning and research, at par with the international standards.

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.

Program Mission

To produce ethically sound and technically competent electrical engineers who can serve in the diverse fields of research, design & development, teaching, system installation, support and maintenance.

Program Educational Objectives

Graduates from Bachelor of Electrical Engineering program are expected to achieve the following Program Educational Objectives and would possess the ability:

PEO 1:

To exhibit the expertise in the field of electrical engineering in order to find the solutions of complex engineering problems.

PEO 2:

To be skillful employable graduates in different areas of design and development, operation and maintenance, technical sales, research, as well as explore opportunities related to entrepreneurship.

PEO 3:

To pursue professional growth by taking up higher studies, learn new technologies, develop proficiency in the usage of new tools.

PEO 4:

To work in multicultural environment and communities, providing leadership in their area, and be sensitive to ethical, moral, and societal issues.

BEE curriculum updating to meet the needs of Industry 4.0 revolution.**(Course outlines)****IDEE Courses**

Course Title: Introduction to Data Science
Course Code: CSC 487
Credit Hours: 3+0
Prerequisite: None

COURSE LEARNING OUTCOMES (CLOs):

By the end of the course, students should be to:

CLO 1	Describe what Data Science is and the skill sets needed to be a data scientist. C1
CLO 2	Use 'R' to carry out basic statistical modeling and analysis. C3
CLO 3	Apply EDA and the Data Science processes and basic machine learning algorithms. C3

MAPPING OF CLOS TO PLOS (PROGRAM LEARNING OUTCOMES):

PLOs		CLOs		
		CLO 1	CLO 2	CLO 3
PLO 01	Engineering Knowledge	✓		
PLO 02	Engineering Problem Analysis			
PLO 03	Designing and Development			
PLO 04	Investigation			
PLO 05	Modern tool usage		✓	
PLO 06	Engineer and Society			
PLO 07	Environment and sustainability			
PLO 08	Professionalism and Ethics			
PLO 09	Communication			
PLO 10	Individual and Team Work			
PLO 11	Life-long learning			✓
PLO 12	Project Management			

Contents:**1. Introduction: What is Data Science?**

Big Data and Data Science hype – and getting past the hype
 Why now? – Datafication
 Current landscape of perspectives
 Skill sets needed

2. Statistical Inference

Populations and samples
 Statistical modeling, probability distributions, fitting a model
 Intro to R.

3. Exploratory Data Analysis and the Data Science Process

Basic tools (plots, graphs and summary statistics) of EDA
 Philosophy of EDA
 The Data Science Process

4. Basic Machine Learning Algorithms

Linear Regression

k-Nearest Neighbors (k-NN)

k-means

Motivating application: Filtering Spam

Why Linear Regression and k-NN are poor choices for Filtering Spam

Naive Bayes and why it works for Filtering Spam

Data Wrangling: APIs and other tools for scrapping the Web

5. Mining Social-Network Graphs

Social networks as graphs

Clustering of graphs

Direct discovery of communities in graphs

Partitioning of graphs

Neighborhood properties in graphs

6. Data Visualization

Basic principles, ideas and tools for data visualization

Examples of inspiring (industry) projects

Exercise: create your own visualization of a complex dataset

7. Data Science and Ethical Issues

Discussions on privacy, security, ethics

A look back at Data Science

Next-generation data scientists

Text Books:

- Cathy O’Neil and Rachel Schutt. Doing Data Science, Straight Talk From The Frontline. O’Reilly. 2014
- An Introduction to Data Science, [Jeffrey M. Stanton](#), [Jeffrey S. Saltz](#)

Course Title: Big Data Analytics
Course Code: CSC-488
Credit Hours: 3+0
Prerequisite: Introduction to data science

COURSE LEARNING OUTCOMES (CLOs):

By the end of the course, students should be to:

CLO 1	Know the fundamental concepts, principles and approaches to description of the Big Data Landscape C1
CLO 2	Use one of the most common frameworks, Hadoop. C3
CLO 3	Solve problems in the professional field on the basis of analysis and synthesis C3

MAPPING OF CLOS TO PLOS (PROGRAM LEARNING OUTCOMES):

PLOS		CLOs		
		CLO 1	CLO 2	CLO 3
PLO 01	Engineering Knowledge	✓		
PLO 02	Engineering Problem Analysis			
PLO 03	Designing and Development			
PLO 04	Investigation			
PLO 05	Modern tool usage		✓	
PLO 06	Engineer and Society			
PLO 07	Environment and sustainability			
PLO 08	Professionalism and Ethics			

PLO 09	Communication			
PLO 10	Individual and Team Work			
PLO 11	Life-long learning			✓
PLO 12	Project Management			

Contents:**Big Data introduction**

- Big data: definition and taxonomy
- Big data value for the enterprise
- Setting up the demo environment
- First steps with the Hadoop “ecosystem”.

The Hadoop ecosystem

- Introduction to Hadoop
- Hadoop components: MapReduce/Pig/Hive/HBase
- Loading data into Hadoop
- Handling files in Hadoop
- Getting data from Hadoop

Querying big data with Hive

- Introduction to the SQL Language
- From SQL to HiveQL
- Introduction to HIVE e HIVEQL
- Using Hive to query Hadoop files

Big data & Machine learning

- Big Data & Machine Learning
- Machine learning tools
 - Spark & Spark ML
 - H2O
 - Azure ML

Software used

Apache Hadoop

Text Books:

- EMC Education Services (2015), *Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data*, Wiley.
- Provost, F., & Fawcett, T. (2013). *Data Science for Business: What You Need to Know about Data Mining and Data Analytic Thinking*, O'Reilly Media.
- Foreman, J.W. (2013). *Data Smart: Using Data Science to Transform Information into Insight*, Wiley.

Course Title: Introduction to Cloud Computing

Course Code: CSC-410

Credit Hours: 3+0

Prerequisite: None

COURSE LEARNING OUTCOMES (CLOs):

By the end of the course, students should be to:

CLO 1	Identify the advantages and disadvantages of various cloud computing platforms, security and privacy issues in cloud computing. C1
CLO 2	Analyze the performance, scalability, and availability of the underlying cloud technologies & software C4
CLO 3	Solve a real-world problem using cloud computing through group collaboration. C3

MAPPING OF CLOS TO PLOS (PROGRAM LEARNING OUTCOMES):

PLOS		CLOS		
		CLO 1	CLO 2	CLO 3
PLO 01	Engineering Knowledge	✓		
PLO 02	Engineering Problem Analysis		✓	
PLO 03	Designing and Development			
PLO 04	Investigation			✓
PLO 05	Modern tool usage			
PLO 06	Engineer and Society			
PLO 07	Environment and sustainability			
PLO 08	Professionalism and Ethics			
PLO 09	Communication			
PLO 10	Individual and Team Work			
PLO 11	Life-long learning			
PLO 12	Project Management			

Content:**Cloud Computing**

Key aspects of cloud computing(cc), Cloud system, Services offered by cc, Old IT infrastructure vs. cloud Web 1.0 to 4.0, SAAS, PAAS and IAAS, Public, Private and Hybrid Cloud.

CRM Introduction

Introduction to CRM, CRM metrics, technologies & Channels.

Salesforce Introduction

Salesforce terminologies, logging into Salesforce, Salesforce user creation and terms, Database.com, Sales Cloud Overview, Editions of Salesforce, Types of Salesforce sandbox, Salesforce development, Tabs, objects and Fields.

Warehouse App

Warehouse App, Custom fields and Objects, Field types (DT) and Tabs.

Relationships, Formulas & Validation

Master-Detail, Lookup and Record Format, Formula, Roll Up Summary and Improve Validation Rule.

Workflow

What is workflow, Evaluation Criteria, Rule Criteria, Salesforce navigation term, Records, Salesforce navigation term – Sidebar, Salesforce.com and Force.com, Database.com, Sales Cloud Overview, Service cloud Overview, Editions of Salesforce, Types of Salesforce sandbox, Salesforce development, Tabs, objects and Fields.

Warehouse App and Relationships

Create Warehouse App, Custom Objects, Custom fields, Create records, Field types (DT). Master-Detail, Lookup, Record Format.

Formulas & Validation

Formula, Roll Up Summary, Improve Validation Rule.

Text Books:

1. Rafaels, R. J. (2015). Cloud Computing: From Beginning to End, Create Space Independent Publishing.
2. Marinescu, D.C. (2013). Cloud Computing Theory and Practice, Elsevier.
3. Erl, T., Puttini, R., & Mahmood, Z. (2013). Cloud Computing: Concepts, Technology & Architecture, Prentice Hall.

Course Title: Artificial Intelligence
Course Code: CSC-412
Credit Hours: 3+0
Prerequisite: Object Oriented Programming.

COURSE LEARNING OUTCOMES (CLOS):

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By the end of the course, students should be to:

CLO 1	Understanding and Recognition of an AI-problem.
CLO 2	Model AI-problems and point out an appropriate solution (for example expert systems, search algorithms, learning).
CLO 3	Describe and use search methods, expert systems, statistical methods and simple methods for learning, discuss different definitions of AI, and relate those to the history of AI.

MAPPING OF CLOS TO PLOS (PROGRAM LEARNING OUTCOMES):

PLOs		CLOs		
		CLO 1	CLO 2	CLO 3
PLO 01	Engineering Knowledge	✓		
PLO 02	Engineering Problem Analysis			
PLO 03	Designing and Development		✓	
PLO 04	Investigation			
PLO 05	Modern tool usage			✓
PLO 06	Engineer and Society			
PLO 07	Environment and sustainability			
PLO 08	Professionalism and Ethics			
PLO 09	Communication			
PLO 10	Individual and Team Work			
PLO 11	Life-long learning			
PLO 12	Project Management			

Content:

- Introduction to AI, history of AI, course logistics, Intelligent agents, uninformed search, Heuristic search, A* algorithm, Adversarial search, games, Constraint Satisfaction Problems, Machine Learning: Basic concepts, linear models. Perceptron, K nearest neighbors, Machine Learning: advanced models, neural networks. SVMs, decision trees and unsupervised learning. Markov decision processes and reinforcement learning. Logical Agent, propositional logic and first order logic, AI applications (NLP), AI applications (Vision/Robotics), Introduction to Deep Learning, Convolution neural network, Recursive Neural Network,

Text Books:

Stuart Russel and Peter Norvig, Artificial Intelligence, A modern Approach, 3rd Edition

Reference Books:

- Michael J. Wooldridge, Reasoning about Rational Agents.
- Jack Minker, Logic Based Artificial Intelligence.
- Steven Michael LaValle, Planning Algorithms

Course Title: Industrial Internet of Things (IIoTs)

Course Code: EET 461

Credit Hours: 3+0

Prerequisite: Object Oriented Programming and Data Communication.

COURSE LEARNING OUTCOMES (CLOs):

By the end of the course, students should be to:

CLO 1	Understanding of pervasive connectivity, storage, and computation to give different
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	IoT based solutions for real world systems.
CLO 2	Students will acquire knowledge necessary for remote monitoring and control of industrial manufacturing/operations facilities through experiential learning as well as remote health monitoring and emergency notification systems, and transportation systems.
CLO 3	Implementation of Multi-Node IoT Solutions and analyze data in the Cloud.
CLO 4	Design of based IoT solutions utilizing IoT sensors, data collection in the Cloud.

MAPPING OF CLOS TO PLOS (PROGRAM LEARNING OUTCOMES):

PLOs		CLOs			
		CLO 1	CLO 2	CLO 3	CLO 4
PLO 01	Engineering Knowledge	✓	✓		
PLO 02	Engineering Problem Analysis				
PLO 03	Designing and Development				✓
PLO 04	Investigation				
PLO 05	Modern tool usage			✓	
PLO 06	Engineer and Society				
PLO 07	Environment and sustainability				
PLO 08	Professionalism and Ethics				
PLO 09	Communication				
PLO 10	Individual and Team Work				
PLO 11	Life-long learning				
PLO 12	Project Management				

Content:

Internet of Things (IoT)

- What Is the Internet of Things?
- Machine to Machine / User-less Communication
- Components of an IoT Solution
- Open Source and Commercial Examples
- Competing Standards for IoT
- IoT specialization: Industrial, Medical/Healthcare, Automotive, Energy/Utilities, Financial

Acquiring Data

- Traditional Data Storage
- Analog and Digital I/O Basics
- Sensors and Data Collection Points
- Embedded Platforms / Microcontrollers
- Software Development
- Device Security: Physical and Logical
- Connecting Sensors to the Cloud
- Scaling Number of Sensors

Utilizing Data

- Collecting and Storage of IoT Sensor Data
- Data Aggregation
- Processing IoT Data
- Privacy and Security
- Analysis and Visualization of Data
- Cloud and IoT
- Big Data and IoT

Implementing IoT

- Embedded Operating Systems
- Linux and Windows-Based IoT
- Cloud-based Data Collection
- On-Going IoT Operations

IoT Analytics

- ETL (Extract-Transform-Load)
- Combining IoT Data with Static Data
- Scripting and Programming with IoT Data
- Machine Learning / Artificial Intelligence

Bringing It Together

- IoT Strategies
- IoT Governance and Management Strategies

What's Next in IoT

Text Book:

- "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).

Reference Book:

- "Internet of Things: A Hands-on Approach", by Arshdeep Bahga and Vijay Madisetti (Universities Press).

Management Science Elective

Course Title: Sales and Marketing Strategies for Engineers
Course Code: MGT-426
Credit Hours: 2+0
Prerequisite: None

COURSE LEARNING OUTCOMES (CLOs):

By the end of the course, students should be to:

CLO 1	Understand the fundamentals of marketing strategies & matrix.
CLO 2	Identify new marketing imperatives intelligence, interfaces & integration.
CLO 3	Gain a clear understanding of the role in supporting the sales and marketing of company's products and services.
CLO 4	To understand how to develop a close business relationship with clients

-
- **MAPPING OF CLOs TO PLOs (PROGRAM LEARNING OUTCOMES):**

PLOs		CLOs			
		CLO 1	CLO 2	CLO 3	CLO 4
PLO 01	Engineering Knowledge				
PLO 02	Engineering Problem Analysis				
PLO 03	Designing and Development				
PLO 04	Investigation		✓		
PLO 05	Modern tool usage				
PLO 06	Engineer and Society	✓			
PLO 07	Environment and sustainability				
PLO 08	Professionalism and Ethics			✓	
PLO 09	Communication				
PLO 10	Individual and Team Work				
PLO 11	Life-long learning				✓
PLO 12	Project Management				

Course Outline:

- **The marketing engineering approach**
- The marketing decision environment, Basic economic concepts for analyzing marketing actions, Tools for marketing engineering, Business value of marketing engineering.
- **Customer value assessment and valuing customers**
- The concept of customer value, approaches to measuring customer value, valuing customers and customer lifetime value.
- **Segmentation and targeting**
- The segmentation, targeting, and positioning approach. Segmentation analysis, traditional segmentation. Targeting individual customers, implementation barriers and solutions.
-
- **Positioning**
- Positioning through brand linkages, positioning using perceptual maps, combining perceptual and preference mapping, translating preference to choose, reverse mapping (from map to raw data) incorporating price as an attribute uses and limitations of perceptual and preference maps.
- **Forecasting**
- Forecasting methods, new product forecasting models and their methods to choose.
- **New product and service design**

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- The new product development process, models for idea generation and evaluation, conjoint analysis for product design.
- **The marketing mix**
- Pricing decisions, resource allocation and the marketing communications and promotions mix, sales promotions: types and effects.
- **The digital, online revolution in marketing**
- The evolution of online technologies, online advertising versus traditional advertising, search analytics, social listening and text analysis.
- **Harvesting value from marketing engineering**
- *Online Analytical Processing (OLAP), Models Offered as Web Services, Intelligent Marketing Systems.*
-
- **Text Book:**
- Principles of Marketing Engineering and Analytics 3rd Edition by Gary Arvind Arnaud. (Decision Pro, Inc.)



Application Form for Stream Selection in BEE Program

1. Name: _____

2. Enrollment No: _____ 3. Registration No: _____

4. Email Address: _____ 5. Phone No: _____

6. Batch: _____

7. Current CGPA: _____

Electrical Machine

Electronic Circuit Design

Signals and System

8. GPA _____

9. Rank stream according to choice of selection (Power / Electronics / Telecommunication):

(i) _____

(ii) _____

(iii) _____

10. Reason for selecting (_____) as your first choice to study at undergraduate level?

Student Signature: _____

Date: _____

Note: Selection will be granted on merit-cum-choice base.

Analysis of low intake and Student dropout ratio in EE department

1. Background

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- The BEE department has done some analysis on low intake and Student dropout ratio. I was observed that dropout ration is around 50%. The following reasons have been identified:
 - Strict policy of chance and dropout considering the quality of intake.
 - Admission are done before Final result of intermediate which is why most students are unable to apply to BUKC
 - Students are generally very weak in Applied Sciences.

It was also discussed that solutions of these identified issues may be resolved. The detailed analysis regarding challenges to the BEE program is attached as Appendage E.

1. Recommendation

- It is recommended to consider the similar policy for Engineering Program as adopted in NED which will help our engineering students to focus more on academic content rather than fulfilling the policy.

Analysis, Comparison, and Challenges of the Student of BEE Program at BUKC:

Current Status (Fall 2019 Intake) of the Student Applied in BEE Program

- 149 students applied and 140 students have cleared the entry test.
- According to the experience, many students join EE BUKC in the second admission

Advertisement. Students usually prefer to join NED, NUST, SSUET etc.

3. Student prefer to join other university mainly because of semester fees (include all expensive), and reputation.
4. It is recommended to offer admission later in August too, and promote all scholarship opportunities. Exam department must guide student in detail how to avail scholarship at the time of form submission.

Challenges to Sustain the Strength of Students

1. It is observed that the students are overwhelm due to strict policy of maintaining CGPA to avoid probation conditions. The probation condition of Bahria University is relatively strict with respect to other university such as NED, Sir Syed etc.
2. The comparison of Bahria policy and NED policy for probation is explained briefly:
 - a) NED allows 2 probations, and after 2nd probation student needs to improve his CGPA of already taken courses without enrolling new courses. Under this condition, if student still can't improve then his admission is cancelled. This policy is only applied in first two years.
 - b) From third year onward, student only need to pass the courses. No Probation or chance will be marked even student CGPA drop below 2.0 from third year onward.
 - c) Bahria University only allows 1 probation and 1 chance. In worst case scenario, student will be dropped from 8th semester of the program, if he/she get probation in 1st semester and he/she get chance in 7th semester.
 - d) According to policy, student has lesser chance of improvement. University allows only 2

summer courses, also he/she can get only B grade maximum which do not help much to improve the grade.

3. It is recommended to consider the similar policy for Engineering Program as adopted in NED which will help our engineering students to focus more on academic content rather than fulfilling the policy.

Appendage 1908

MS COMPUTER ENGINEERING

Vision Statement of the Department:

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.

Mission Statement of the Program:

The mission of the Master of Science in Computer Engineering program is to educate graduates by enhancing their knowledge of computer engineering with theory, practice and research to cater technological advances for the betterment of society.

Program Educational Objectives:

The educational objectives of MSCE program are stated as below:

1. Ability to apply theoretical and practical knowledge to solve challenging problems in their professions.
2. Ability to engage in life-long learning for personal and societal growth.
3. Ability to demonstrate effective interpersonal skills as an individual or in a team.

Learning Outcomes of the Program:

The MSCE program prepares students to attain the educational objectives by ensuring that students demonstrate achievement of the following learning outcomes. Students should be:

1. Able to provide solutions of complex engineering problems using computer engineering knowledge, methodologies and principles.
2. Able to understand research aspects of computer engineering and its allied domains.
3. Able to communicate effectively, in both oral and written form.
4. Able to recognize importance of technological developments and pursue lifelong learning.

Admission Eligibility Criteria:

HEC recognized 4 years Bachelor's Degree or equivalent in a relevant computing discipline (Computer Engineering, Computer Science, IT, Software Engineering, Electrical Engineering, Electronics Engineering, Information Systems & Informatics or equivalent) with a minimum CGPA of 2.5/4.0 or 50% marks where CGPA is not given. The following courses (or equivalent) are pre-requisite for the MS Computer Engineering program:

- 1. Digital Logic Design or equivalent**
- 2. Computer Architecture and Organization or equivalent**
- 3. Differential Equation or equivalent**

Students shall be required to complete the deficiency courses (as mentioned above) if required. Applicants must also provide HEC verification of all academic degrees and transcripts as per BU rules.

MS Computer Engineering Roadmap
Bahria University, Islamabad

Campus:	BUIC
Department:	Computer Engineering
Program Title:	MS Computer Engineering
Program Level:	Postgraduate
Duration of Program:	2 Years
Number of semesters:	4 Semester
Total Credit Hours	30

Semester-1

S.No.	Course Code	Course Title	Credit Hours
1		Core-I	3
2		Core-II	3
3	ESC 701	Research Methodology	3
Total Credit Hours			9

Semester-2

S.No.	Course Code	Course Title	Credit Hours
1		Core-III	3
2		Elective -I	3
3		Elective -II	3
Total Credit Hours			9

Semester-3

S.No.	Course Code	Course Title	Credit Hours
1		Elective -III	3
2		Elective –IV / Thesis- I	3
Total Credit Hours			6

Semester-4

S. No.	Course Code	Course Title	Credit Hours
1		Elective -V	3
2		Elective –VI / Thesis- II	3
Total Credit Hours			6

Core Courses

S. No.	Course Code	Course Title	Credit Hours
1	CEN 525	Digital Signal Processing & Applications	3
2	CEN 520	Advanced Computer System Architecture	3
3	CEN 524	Advanced Digital Design	3
Total Credit Hours			9

List of Elective Courses

S. No.	Course Code	Course Title	Credit Hours
1	CSC 751	Pattern Recognition	3
2	CSC 764	Computer Vision	3
3	CSC 719	Machine Learning	3
4	CSC 711	Advanced Artificial Intelligence	3
5	CSC 765	Bio Medical Image Analysis	3
6	CEN 745	Advanced Digital Image Processing	3
7	CSC 518	Decision Support Systems	3
8	CEN 740	Advanced Embedded Systems	3
9	CSC 720	Advanced Operating Systems	3
10	CEN 707	Advanced Distributed Systems	3
11	CEN 553	Real Time Computer Systems	3
12	CSC 758	Parallel Processing	3
13	CEN 752	Advanced VLSI System Design	3
14	CEN 541	ASIC and FPGA Design	3
15	CEN 721	Advanced Microprocessor Systems	3

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16	CEN 753	Design of Real Time Embedded Systems	3
17	CSC 502	Information Systems	3
18	EET 710	Advanced Computer Networks	3
19	EET 511	Digital Communication Systems	3
20	EET 556	Mobile Communication & Networking	3
21	EET 548	Mobile Cellular Systems and Standards	3
22	EET 554	Wireless Networks	3
23	EET 755	Wireless Communication Techniques	3
24	EET 555	Wireless and Mobile Communications	3
25	EET 702	Advanced Network Security	3
26	EET 553	Information Theory and Coding	3
27	EET 519	Distributed Networking	3
28	EET 520	Network Administration & Management	3
29	EET 706	Advanced Optical Fiber Networks	3
30	EET 711	Advanced Digital Communications	3
31	EET 769	Mobile/Vehicular Ad Hoc Networks	3
32	GSC 700	Advanced Engineering Mathematics	3
33	EEN 510	Stochastic Processes	3
*35	CSC 704	Advanced Cryptography	3
*36	SEN 762	Advanced Big Data Analytics	3
*37	DSC 707	Deep Learning	3
*38	CSC 781	Cloud Computing	3
*39	ISC 737	Computer and Network Forensics	3
*40	SEN 774	IoTs Architecture, Protocols & Applications	3

***New electives have been added**

Course Outlines

Course Title: Digital Signal Processing & Applications

Course Code: CEN 525

Credit Hours Theory: Three (3)

Course Outline:

This course on Digital Signal Processing will discuss topics including Discrete-time Signals, Input-Output relationships, Discrete-Time Networks, Sampling of Signals, Discrete Fourier Transform & Fast Fourier Transform (FFT) Algorithms, IIR, FIR Filters, Design of signal-processing system, Advanced digital filter design, Multi-rate DSP, adaptive filter theory, FFT and DSP applications.

Recommended Book:

Oppenheim, A.V., Schaffer, R.W, "Discrete-Time Signal Processing", Second Edition, Prentice-Hall, New Jersey, 1999, ISBN 0-13-083443-2.

Reference Books:

S. K. Mitra, "Digital signal processing: A computer based Approach, 4th edition", McGraw-Hill

Course Title: Advanced Computer System Architecture

Course Code: CEN 520

Credit Hours Theory: Three (3)

Course Outline:

This course is a study of the evolution of computer architecture and the factors influencing the design of hardware and software elements of computer systems. Topics may include: instruction set design; processor micro-architecture and pipelining; cache and virtual memory organizations; protection and sharing; I/O and interrupts; in-order and out-of-order

superscalar architectures; VLIW machines; vector supercomputers; multithreaded architectures; symmetric multiprocessors; and parallel computers.

Recommended Book:

Hennessy, J. L., and D. A. Patterson. “Computer Architecture: A Quantitative Approach”, 3rd edition

Reference Books:

W. Stallings “Computer Architecture and Organization” 10th edition, McGraw-Hill

Course Title: Advanced Digital Design

Course Code: CEN 524

Credit Hours Theory: Three (3)

Course Outline:

This course is dedicated to advanced topics in digital system design including Application Specific Integrated Circuits, System on Chip (SoC), Validation and Verification, Simulation, Hardware acceleration, Hardware Descriptive language (HDL), from specification to model, Application-specific instruction-set processor (ASIP) design, Field programmable gate array (FPGA), Hardware Design Methodologies, EDA (Electronic Design Automation), Programmable logic devices:

PLA, PAL, GAL, CPLD and FPGA.

Recommended Book:

W. Wolf, FPGA based System Design”, latest edition, Prentice Hall

Reference Books:

S.A.Khan, Digital Design of Signal Processing System: A Practical Approach”, Wiley

Course Title: Advanced Big Data Analytics

Course Code: SEN 762

Credit Hours Theory: Three (3)

Course Outline:

This course shall provide the fundamental knowledge to equip students being able to handle those challenges. This discipline inherently involves many fields. Because of its importance and broad impact, new software and hardware tools and algorithms are quickly emerging. A data scientist needs to keep up with these ever changing trends to be able to create a state-of-the-art solution for real-world challenges.

This Big Data Analytics course shall first introduce the overview applications, market trend, and the things to learn. Then, students shall be introduced fundamental platforms, such as Hadoop, Spark, and other tools, such as IBM System G for Linked Big Data. Afterwards, the course will introduce several data storage methods and how to upload, distribute, and process them. This shall include HDFS, HBase, KV stores, document database, and graph database. The course will go on to introduce different ways of handling analytics algorithms on different platforms. Then, students shall introduce visualization issues and mobile issues on Big Data Analytics. Students will then have fundamental knowledge on Big Data Analytics to handle various real-world challenges.

Afterwards, the course will zoom in to discuss large-scale machine learning methods that are foundations for artificial intelligence and cognitive networks. The course will discuss several methods to optimize the analytics based on different hardware platforms, such as Intel & Power chips, GPU, FPGA, etc. The lectures will conclude with overview of the future challenges of Big Data, especially on the ongoing Linked Big Data issues which involves graphs, graphical models, spatio-temporal analysis, cognitive analytics, etc.

Given large amount of data, one fundamental scientific challenge is how to develop efficient and effective computational tools to analyze the data, revealing insight and make predictions. Data analytics is the science of achieving these goals. It is an inter disciplines of machine learning, data mining, statistics, and so on. This class aims to provide an overview of

advanced machine learning, data mining and statistical techniques that arise in data analytic applications. In this class, you will learn and practice advanced data analytic techniques, including: parallel algorithms, online algorithm, locality sensitive hashing, topic modelling, structure learning, and time-series analysis.

Recommended Books:

C. Bishop, Pattern Recognition and Machine Learning, Springer 2007.

All of statistics: a concise course in statistical inference. Larry Wasserman. Springer, 2004

Course Title: Deep Learning

Course Code: DSC 707

Pre-Requisite: None

Course Description:

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.

Salient contents of the course are: Introduction to neural networks, activation functions and back propagation; Convolutional Neural Networks: History, Convolution, Pooling, CNNs for classification, Deep learning Software, CNN Architectures; Sequence Modeling: Recurrent and Recursive Nets: Long Short Term Memory models and variants, Language modeling and image captioning, Unsupervised learning: Restricted Boltzmann Machines and Auto encoders; Case Studies.

Reference Books:

Goodfellow, I., Bengio, Y., & Courville, A. (2016). Deep Learning (Adaptive Computation and Machine Learning series), The MIT Press, 2016.

Patterson, J., & Gibson, A. (2017). Deep Learning: A Practitioner's Approach, O'reilly

Course Title: Computer and Network Forensics

Course Code: ISC 737

Pre-Requisite: None

Objectives:

The objectives of this course are to study computer and network security principles and practices for crime investigations and other legal actions. The students will learn how to use forensically-sound methodologies and software to acquire admissible electronic evidence with coverage areas of networks, computer, email forensics and cell phone forensics.

Contents:

Forensics Essentials and Criminalistics, Essentials of OS and Networking (Review), Forensic Modelling and Principles, Forensic Duplication, Forensics Analytics, File Carving, Cyber Forensics Tools and the Testing Thereof, Email forensics, Mobile Device Forensics, Network Surveillance and Accountability, Network Attack Trace back and Attribution, Multicast Fingerprinting, Multimedia Forensics, Intrusion and Online Frauds Detection, Steganography & Steganalysis, Anonymity/ Pseudonymity/ P3P, Cyber Law, Security and Privacy Policies and Guidelines, Ethical issues, Court Testimony and Report Writing Skills.

Text Books:

Guide to Computer Forensics and Investigations by Bill Nelson

Network Forensics: Tracking Hackers through Cyberspace by Sherri Davidoff

Reference Books:

Computer Forensics: Investigating Network Intrusions and Cyber Crime published by EC-Council Press

Computer Forensics: Principles and Practices by Linda Volonino

Course Title: Cloud Computing

Course Code: CSC 781

Pre-Requisite: None

Objectives:

Understanding the systems, protocols and mechanisms to support cloud computing, Application architectures for cloud computing, understanding the hardware necessary for cloud computing and design and implementation of cloud computing application

Contents:

This course introduces students to the cloud and the computing on the cloud. Initially, the focus is on the technology context, i.e. multi-core architectures, virtualization, parallel computing models and big data storage. Next, famous cloud computing models including Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS) are studied with the help of Amazon AWS (IaaS), Microsoft Azure (PaaS) and Google App Engine (SaaS). In addition to computing models, Data and computation models, e.g. MapReduce, are an important part of this module. The theoretical concepts are explained with hand-on experience of cloud platforms supported by case studies. The course concludes with an insight into the cloud risk areas including risks with service provider, technical risks, security issues, connectivity issues, etc. and research work in these areas is also discussed.

Text Books:

Handbook of Cloud Computing, Borko Furht. Springer, 2010.

Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security, and More, Kris Jamsa Jones & Bartlett Publishers, 2012

Reference Books:

Cloud Computing and SOA: Convergence in your enterprise, David Linthicum. Addison Wesley, 2009

Course Name: Advanced Cryptography

Course Code: CSC 704

Credit Hours: 3

Course Description:

This course focuses on modern cryptography. It includes building blocks such as one way functions, pseudo random number generation, encryption, and digital signatures, protocols and applications such as information security, secure network communication, secure cloud computing, and privacy preserving data analytics. Fundamental security properties, cryptographic constructions, and their applications are emphasized.

Reference Books:

Katz, J., Lindell, Y. (2014). Introduction to Modern Cryptography, 2nd Edition, CRC Press.

Ferguson, N., Schneier, B., & Kohno, T. (2011). Cryptography Engineering: Design Principles and Practical Applications, by Niels Ferguson, Bruce Schneier and Tadayoshi Kohno, Wiley Publishing Inc.

Appendage 1911

Internet of Things and Artificial Intelligence (Theory)	
Course Code:	EET-XXX
Credit Hours:	3+1
Pre-requisite:	CEN222: Data Communication & Networking & GSC 123: Probability Methods in Engineering
Objectives:	The course aims to familiarize students with the fundamentals

	of Internet of Things and Artificial Intelligence so that they are able to design and analyze new solutions for the wide range of AI based industrial IoT applications.
Course Learning Outcomes (CLOs):	<p>After taking this course, students will be able to:</p> <p>CLO 1 (C2): Explain the fundamentals of IoTs and AI.</p> <p>CLO 2 (C4): Analyze the existing AI based IoT systems and be able to make any system intelligent.</p> <p>CLO 3 (C5): Design the robust AI based IoT systems from scratch.</p>
Course Outline:	<p>Introduction to Internet of things? What and Why?</p> <p>Internet in general and Internet of Things: layers, protocols, packets, services, performance parameters of a packet network as well as applications such as web, Peer-to-peer, sensor networks, and multimedia.</p> <p>Transport services: TCP, UDP</p> <p>Network layer: forwarding & routing algorithms (Link, DV), IP-addresses, DNS, NAT, and routers.</p> <p>Local Area Networks, MAC level, link protocols such as: point-to-point protocols, Ethernet, WiFi 802.11, cellular Internet access, and Machine-to-machine.</p> <p>Mobile Networking: roaming and handoffs, mobile IP, and ad hoc and infrastructure less networks.</p> <p>Hardware and Software for IoT</p> <p>Edge and Cloud Computing for IoT</p> <p>Artificial Intelligence (AI) for Internet of Things (IoT)</p> <p>Turing Test</p> <p>Searches (BFS, DFS, GFS, A*)</p> <p>Game theory, minimax, alpha-beta pruning</p> <p>Optimizations: Genetic Algorithm, Particle Swarm Optimization</p> <p>Different Streams of AI</p> <p>Natural Language Processing</p> <p>Machine Learning</p> <p>Reinforcement Learning</p> <p>Supervised and Unsupervised Learning</p> <p>Classification and Regression</p> <p>Supervised Classification Models (KNN, Naïve Bayes, GMM, SVM, Decision Trees, Artificial Neural Networks)</p> <p>Unsupervised Classification Models (K-means Clustering, Hierarchical Clustering, Mean Shift Clustering, Density Based Clustering)</p> <p>Introduction to Deep Learning</p> <p>Embedded Systems for IoTs</p> <p>Blockchain and IOTA Technologies for IoT</p>

Resources:	<ul style="list-style-type: none"> Stuart Russel, Peter Norvig, “Artificial Intelligence: A Modern Approach”, 3rd Edition Pattern Classification by Richard O. Duda, Peter E. Hart and David G. Stork (2nd Edition)
Tools:	Python IDLE MATLAB R2019a ML.NET (C#)

Mapping of CLO to PLOs

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

CLOs	MAPPED PLO	LEVEL	CONTRIBUTION
CLO 1: Explain the fundamentals of IoTs and AI.	PLO 1	C2	3
CLO 2: Analyze the existing AI based IoT systems and be able to make any system intelligent.	PL02	C4	3
CLO 3: Design the robust AI based IoT systems from scratch.	PLO3	C5	3

Grading Rubric

Assessment Method	CLO 1	CLO 2	CLO 3
Final Exam	X	30	20
Midterm Exam	6	14	x
Assignments	4	9	7
Quizzes	2	4	4
Total (100)	12	57	31

Prepared By: Dr. Saleem Aslam

Introduction to Heating, Ventilation and Air-Conditioning	
Course Code:	EEN-400 level (to be assigned)
Credit Hours:	3
Pre-requisite	BME
Course Objectives:	<p>Develop basic understanding of the complete refrigeration and cooling cycle from compression to evaporation.</p> <p>Develop complete understanding of commercial HVAC units, thermal comfort, relationship between pressure, temperature and volume of refrigerant gases.</p> <p>Develop the ability to choose the right type of equipment for any building cooling load.</p>
Course Learning Outcomes (CLOs)	<p>At the end of the course the student should be able to</p> <p>CLO1: (C1): Describe the main components of an HVAC system</p> <p>CLO2: (C2): Perform basic calculations related to HVAC systems like heat load, power requirements, building load, sizing of equipment</p> <p>CLO3: (C2): Illustrate understanding of gas laws and Psychrometric charts related to HVAC system</p> <p>CLO4: (C3): choose between different types of compressors, condensers, evaporators, gases for a particular building application</p>

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Course Outline:	<p>Fundamentals of refrigeration</p> <p>Latent, specific, sensible heat</p> <p>Dew point, WBT, DBT, comfort</p> <p>HAVC components</p> <p>Types of compressors</p> <p>Psychrometric charts</p> <p>Energy power and work calculations</p> <p>Thermal units like BTUs, KJ etc</p> <p>Heating load calculations</p> <p>Types of HVAC systems</p> <p>Vapour compression systems</p> <p>Central heating and cooling</p> <p>Domestic AC systems and their trouble shooting</p>
Resources:	<p>Textbooks:</p> <p>Modern Refrigeration & Air Conditioning By Athous Tranquest And Good Heart</p> <p>2. Principles of Refrigeration By R.J Dossat</p> <p>Reference Book:</p> <p>Refrigeration & Air Conditioning Practice By Billy C. Langelly</p>

Mapping of CLO to PLOs

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

CLOs	MAPPED PLO	LEVEL	CONTRIBUTION
CLO 1: Describe the main components of an HVAC system	PLO 1	C1	2
CLO 2: Perform basic calculations related to	PLO1	C2	2

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HVAC systems like heat load, power requirements, building load, sizing of equipment			
CLO 3: Illustrate understanding of gas laws and Psychrometric charts related to HVAC system	PLO1	C2	2
CLO4: choose between different types of compressors, condensers, evaporators, gases for a particular building application	PLO3	C3	3

Grading Rubric

Assessment Method	CLO 1	CLO 2	CLO 3	CLO4
Final Exam	5	5	20	20
Midterm Exam	10	10		
Assignments	5	5	5	5
Quizzes	2.5	2.5	2.5	2.5
Total (100)	22.5	22.5	27.5	27.5

Prepared By: Engr. Jehanzeb Ahmad

Introduction to Renewable Energy	
Course Code:	EEN-400 level (to be assigned)
Credit Hours:	3
Pre requisite:	None
Course Objectives:	<p>This is an undergrad level course covering basic theory, analysis and design of different forms of alternate energy resources that includes solar, wind, tidal, biomass, geothermal and hydroelectric resources. Main objective is to motivate the students to be able enough to realize the feasibility and the cost analysis of a proposed hybrid power system</p>
Course learning outcomes (CLOs)	<p>At the end of the course the student should be able to</p> <p>CLO1: (C1): Describe the main components of a renewable energy system</p> <p>CLO2: (C2): Perform basic calculations related to renewable energy system availability of solar / wind profile, size of solar array / wind turbine and power</p>

	<p>production capability of generating units.</p> <p>CLO3: (C2): Demonstrate understanding related to first principles of physics and mathematical modeling of solar cells, fuel cells, windmills etc.</p> <p>CLO4: (C3): To be able to evaluate different power backup schemes (comprising of solar, wind, micro-hydropower solutions or etc.) and hence chose the best possible option.</p>
Course Outline:	<p>This course covers the following aspects of renewable energy resources.</p> <p>Introduction to Primary energy sources and their distribution</p> <p>Why we need renewable energy</p> <p>Introduction to renewable energy</p> <p>Climate Change</p> <p>Hydro power</p> <p>Photo Voltaics</p> <p>Solar Thermal systems</p> <p>Solar Power plants</p> <p>Wind power systems</p> <p>Geothermal energy</p> <p>Heat Pumps</p> <p>Biomass</p> <p>Hydrogen and fuel cells</p>
Resources:	<p>Renewable energy and climate Change by Volker Quaschnig, Wiley Publishers, IEEE</p> <p>Renewable Energy – Technology, economics and environment by Martin Kaltschmitt, Wolfgang Striecher, and Andreas Wiese</p>

CLOs	MAPPED PLO	LEVEL	CONTRIBUTION
CLO 1: Describe the main components of a renewable energy system	PLO 1	C1	2
CLO 2: Perform basic calculations related to renewable energy system availability of solar / wind profile, size of solar array / wind turbine and power production capability of generating units.	PLO1	C2	2
CLO 3: Demonstrate understanding related to first principles of physics and mathematical modeling of solar cells, fuel cells, windmills etc.	PLO1	C2	2
CLO4: To be able to evaluate different power backup schemes (comprising of solar, wind, micro-hydropower solutions or etc.) and hence chose the best possible option.	PLO3	C3	3

Grading Rubric

Assessment Method	CLO 1	CLO 2	CLO 3	CLO4
Final Exam	5	5	20	20
Midterm Exam	10	10		
Assignments	5	5	5	5
Quizzes	2.5	2.5	2.5	2.5
Total (100)	22.5	22.5	27.5	27.5

Prepared By: Engr. Muneeb Yaqub

Appendage 1912**MSEE(Systems Engineering)****Semester 1**

Core-I

Stochastics Process (EEN-510)

Core-II

Advanced Digital Communication (EET-711)

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	Elective-I	
Semester 2	Core-III	Modern Control Theory (EEN-726)
	Core-IV	Advance Digital System Design (CEN-742)
	University Requirement	
Semester 3	Elective-I	
	Elective-II/Thesis-I	
Semester 4	Elective-III/Elective-II	
	Elective-IV/Thesis-II	

Elective Courses

Sr. No.	Course Code	Elective Course Title	Credit Hours
1.	ESE-701	Introduction to Systems Engineering	3
2.	ESE-702	Systems Engineering Management	3
3.	ESE-703	Configuration Management	3
4.	ESE-704	Quality Management	3
5.	ESE-705	System of Systems Engineering	3
6.	ESE-706	System Integration and Validation	3
7.	EET-723	Optimization Techniques	3
8.	EEN-725	Advanced Digital Signal Processing	3
9.	EEA-767	Fuzzy Logic & Intelligent Electronics Control Systems	3
10.	EEP-712	Advanced Power Electronics	3
11.	CEN-745	Advanced Digital Image Processing	3
12.	EET-702	Advanced Network Security	3
13.	ESC-501	Research Methodology	3

14.	CSC-708	Advanced Simulation & Modeling	3

Introduction to Systems Engineering	
Course Code:	ESE-701
Credit Hour:	3
Pre requisite:	None
Objectives:	<p>This course introduces students to the fundamental principles of systems engineering and their application to the development of complex systems. It describes how the systems engineering viewpoint can be brought to bear to address engineering challenges as well as the essential role of systems engineering in project management. Topics include defining systems, the system development life cycle, and the systems engineering method. These primary topics are decomposed into requirements analysis, functional design, physical design, design validation, concept development, engineering development, and post development. In addition, the tools and methods at the systems engineer's disposal are also covered. These include risk analysis, configuration management, design trade-offs, modeling and simulation, and interface management, as well as how these subjects are linked to systems program management activities. The course defines the breadth and depth of the knowledge that the systems engineer must acquire concerning the characteristics of the diverse components that constitute the total system. Students will work as a group to develop the document that serves as a foundation for all systems engineering activity for a specific project, the Systems Engineering Management Plan (SEMP).</p>

Course Outline:	<p>Foundations of Systems Engineering.</p> <p>Systems Engineering & the world of modern systems</p> <p>Systems Engineering Landscape</p> <p>The system development process</p> <p>System Engineering management</p> <p>Concept Development stage</p> <p>Needs Analysis</p> <p>Concept Exploration</p> <p>Concept Definition</p> <p>Decision Analysis & Support</p> <p>Engineering Development stage</p> <p>Advanced Development</p> <p>Software Systems Engineering</p> <p>Engineering Design</p> <p>Integration & Evaluation</p> <p>Post Development Stage</p> <p>Production</p> <p>Operations & Support</p> <p>Retirement & Disposal</p>
Resources:	<p>Introduction to Systems Engineering by Andrew P. Sage, Armstrong Jr. and James E.</p> <p>Introduction to Systems Engineering Kindle Edition by Ian Faulconbridge and Michael Ryan.</p>

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	Systems Engineering Fundamentals, supplementary text prepared by the defense acquisition university press fort Belvoir, Virginia 22060-5565.
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Systems Engineering Management	
Course Code:	ESE-702
Credit Hour:	3
Pre requisite:	None
Objectives:	<p>Objectives of the course are:</p> <p>To provide the students an opportunity to look Systems Engineering from both a technical and management perspective.</p> <p>To introduce the students to the management philosophy of full range Systems Engineering concepts, tools, and techniques</p>
Course Outline:	<p>Introduction to System Engineering Management</p> <p>Need for SE Management, SE Management vs Project Management, SE Processes – Technical vs Management, Guiding Principles of SE Management, Overview of Topics in SE Management</p> <p>Project Management Overview</p> <p>What is PM? Common Reasons of Project failure, project management office, Processes and interactions, Decision gates,</p>

	<p>Generic life cycle stages</p> <p>System Engineering Program Planning</p> <p>Why to plan? What to Plan? Planning process, Integration of plans, SEMP, SOW and SE Tasks, WBS, Outsourcing process, RFPs, proposal evaluation, contracts, supplier monitoring</p> <p>Project Scheduling</p> <p>Program scheduling, System engineering master schedule, Charts (Bar/Milestone/Gantt), Activity relationships, network-based methods (CPM/PERT), crashing, Design Structure Matrix (DSM)</p> <p>Cost Management</p> <p>Activity Resource Estimation, preparing cost projections, CBS, Earned Value Management, Life Cycle cost analysis</p> <p>Risk Management</p> <p>What and where is risk? Why Risk Management? Risk Measurement, Types of risk, RM Process – planning, identification, analysis, handling approaches, monitoring, Risk to/of/by the solution, Risk Management Plan</p> <p>Organization of SE</p> <p>Corporate structure, customer-producer-supplier relationships, Organization and functions (customer/producer/supplier), Functional/Product-line/Matrix structures, selection of project organization, Integrated product and process development, integrated product/process teams</p> <p>Human Aspects of SE Management</p> <p>Human Resource Management, Leadership Characteristics, Interaction between individuals in various roles, Staffing and personnel training</p> <p>SE Program Evaluation</p> <p>Benchmarking, Evaluation of SE Organization, Technical Reviews and Audits, Program reporting, Feedback and control</p>
Resources:	<p>Benjamin S. Blanchard, <i>System Engineering Management</i>. 5th ed. Wiley</p> <p>Howard Eisner, <i>Essentials of Project and Systems Engineering Management</i>, 2nd ed. Wiley.</p> <p><i>Guide to the Systems Engineering Body of Knowledge (SEBoK)</i>,</p>

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	2016 Editor: Richard D. Adcock
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Configuration Management	
Course Code:	ESE-703
Credit Hour:	3
Pre requisite:	ESE-701
Objectives:	<p>This course provides a sound understanding of the field of Configuration & Data Management (C&DM). It supplies a comprehensive approach to configuration management from a variety of product development and IT perspectives, including extending products for a variety of markets due to configuration options.</p> <p>After the completion of the course the students will be able to</p> <p>Explain the interplay of configuration and data management with</p>

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	<p>all enterprise resources during each of the phases of a product lifecycle.</p> <p>Understand Dynamics of change, configuration and market adaptation, adaptive radiation, design reuse and common design lead the way.</p>
Course Outline:	<p>Overview of the Product Life Cycle</p> <p>Overview of the Supporting Enterprise Infrastructure</p> <p>Functional Resources</p> <p>Configuration Management and Product Management</p> <p>Data Definition, Data Types, and Control Requirements</p> <p>Configuration Management Support of Functional Resources</p>
Resources:	<p>Configuration management: Theory, Practice and Application</p> <p>Jon M. Quigley and Kim L. Robertson</p>

Quality Management	
Course Code:	ESE-704
Credit Hour:	3
Pre requisite:	None
Objectives:	Applying TQM (Total Quality Management) to systems engineering can reduce costs while simultaneously improving product quality. The application of this course to proactive systems engineering will help the students to develop and optimize a practical approach, while highlighting the pitfalls and potentials involved.
Course Outline:	<p>The Total Quality Approach to Quality Management: Achieving Organizational Excellence Quality and Global Competitiveness</p> <p>Quality Management, Ethics, and Corporate Social Responsibility</p> <p>Quality Culture: Changing Hearts, Minds, and Attitudes</p> <p>Strategic Management: Planning and Execution for Competitive Advantage</p> <p>Customer Satisfaction, Retention, and Loyalty</p>
Resources:	<p>Applying Total Quality Management to Systems Engineering by Joe Kasser</p> <p>Introduction to Total Quality (Management) by David L. Goetsch, Stanley Davis</p>

System of Systems Engineering	
Course Code:	ESE-705
Credit Hour:	3
Pre requisite:	ESE-701
Objectives:	<p>Upon completion of this course, the students will:</p> <p>Understand The system-of-systems background of Large-scale Systems</p> <p>Understand differences and similarities between Systems and Systems of Systems</p> <p>How to apply the benefits of systems thinking and systems engineering to a “real-world” System of Systems (SoS) project</p> <p>Describe System of Systems engineering (SoSE) functions, life cycle, management, problems, and challenges</p> <p>Explore SE Processes Applied in SoS Environments</p> <p>Apply process, strategy, model, or methodology for System of Systems engineering</p> <p>Apply System of Systems engineering (SoSE) architectures</p> <p>Understand the Details of Technical Management Processes and Technical Processes</p> <p>Be able to structure and lead a conceptual design effort apply to System of Systems</p> <p>Apply System of Systems engineering tools and techniques to real world problems</p> <p>Develop a systems engineering plan for a System of Systems project</p>
Course Outline:	<p>Introduction to System of Systems (SoS)</p> <p>The system-of-systems approach</p> <p>Purpose of SoS</p> <p>Types of SoS</p> <p>Capabilities of SoS</p> <p>Net-Centricity</p>

	Comparison of Systems and Systems of Systems Introduction to System of Systems Engineering (SoSE) System of Systems Architecting Emergence in System of Systems
Resources:	System of Systems Engineering: Innovations for the 21st Century <u>Mohammad Jamshidi</u>

System Integration and Validations	
Course Code:	ESE-706
Credit Hour:	3
Pre requisite:	ESE 701
Objectives:	<p>The purpose of the course is to provide the students with knowledge on system integration and how to apply it in system engineering contexts.</p> <p>After the course the student will have a firm, all round knowledge on a fundamental approach integration of large complex systems, which should result in genuinely innovative system design and considerable improvements at all stages of the system lifecycle.</p>
Course Outline:	<p>Foundations of System Integration</p> <p>Historical perspective, DoD vs. Commercial Market, Integration basics, Fundamental integration mechanism, Integration Components, Spaces and cells</p> <p>System Integration Contexts</p> <p>Process, People, Product Integration, Standards and guidelines, MIL-STD-499B</p> <p>People Integration:</p> <p>Projectized, Functional and Matrix structure, Enterprise Integration Executives and Teams, PIT, PDT</p> <p>Requirements Integration</p> <p>RTM: Unidirectional vs. Bidirectional, Requirement Integration activities, Requirement Set attributes, Requirements Change</p>

	<p>Management and Tools</p> <p>Integrated Program Planning:</p> <p>SEP vs. SEMP, Program Plan Tree with example, Generic Program Planning Data, Integrated Management System, Generating Six documents for integrated planning</p> <p>Process Integration:</p> <p>Process improvement programs and differences (CMM, CMMI, ISO 9000), Quality, Quality factors and control</p> <p>CAD/CAM/CAE/CIM: Scope and Differences, Products and applications</p> <p>Product Integration & Qualification (Verification, Validation and Acceptance) Qualification Methods and laws of testing</p> <p>Audit and Review: Need for audit, audit types, Categories of Internal Control, Testing of System, Limitations of testing, Testing stages, Inspection vs. Testing</p>
Resources:	<p>Langford, G. O., <i>Engineering Systems Integration: Theory, Metrics, and Methods</i>, 1st ed. CRC Press, 2012</p> <p>Blanchard, Benjamin S., Fabrycky, Walter J., <i>Systems Engineering and Analysis</i>, 5th ed. Prentice Hall International Series, 2010.</p>



Department of Computer Science

Bahria University, Islamabad Campus

MS (T&N) Program

Program Mission

The mission of this program is to produce professionals in the field of telecom and networking who are not only adept with the modern-day technology but also abreast with the pace of ever expanding knowledge.

Program Objectives

The key objectives of the MSTN program include the following.

Demonstrate a broad knowledge of telecom and networking and a focused understanding of their area of expertise.

Apply their knowledge and analytical skills to create effective and novel solutions to both practical and research problems.

Adapt to rapidly changing technology and engage in life-long learning.

Program Learning Outcomes

Students receiving MS degree in Telecom and Networking should be able to:

Ability to apply the knowledge and skills acquired during the program to solve practical problems in the fields of Telecommunications and networking.

Acquaintance with the latest tools and technologies.

Ability to communicate effectively in written and oral form.

Ability to pursue continuous professional development.

Ability to work on practical and research-based problems collaboratively as well as independently.

Eligibility Criteria

4 years degree in BS/BCE/BE/B.Sc (Hons) in CS/SE/CE/IT, from HEC recognized university and minimum CGPA 2.5/4.0 or equivalent as per BU rules

OR

MCS/M.Sc. (CS) degree with minimum CGPA 2.5/4.0 or equivalent percentage.

NTS GAT/GRE (General)/ University Test passed with 50% marks.

DISTRIBUTION OF CREDIT HOURS

Category	Credit Hours
Core Courses	15
University Requirement	3
Elective Courses	6
Thesis	6
Total credit hours	30

ROADMAP

Course Code	Course Title	Credits
Semester 1		
ESC 701	Research Methodology	3
EET 511	Digital Communication Systems	3
EET 520	Network Administration and Management	3
	Total	9
Semester 2		
ISC 512	Computer and Network Security	3
EET 556	Mobile Communications and Networking	3
	Elective-I	3
	Total	9
Semester 3		
EET 519	Distributed Networking	3
	Elective-II	3
ESC 500/Elective Code	Thesis-I/Elective-III	3
	Total	9
Semester 4		
ESC 500/Elective	Thesis-II/Elective-IV	3

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Code		
	Total	30

List of Courses

SNo.	Course Code	Course Title	Credits
1.	ISC-512	Computer and Network Security	3
2.	EET-556	Mobile Communications and Networking	3
3.	EET-511	Digital Communication Systems	3
4.	EET-519	Distributed Networking	3
5.	EET-520	Network Administration and Management	3
University Requirement			
1.	ESC-701	Research Methodology	3
Electives			
1.	ESC-500/Code	Thesis-I	3
	ESC-500/Code	Thesis-II	3
2.	EET-702	Advance Computer Networks	3
3.	EET-523	Communication System Analysis and Design	3
4.	EET-549	Advanced Satellite Communication	3
5.	EET-560	Telecommunication Network Management	3
6.	EET-703	DSP Application in Telecommunication	3
7.	EET-705	Broadband Technologies and Components	3
8.	EET-706	Advanced Optical Fiber Networks	3
9.	EET-707	Telecommunications Business Environment	3
10.	EET-718	Network Planning and Evaluation	3
11.	EET-751	Antenna and Microwave Engineering	3
12.	EET-553	Information Theory and Coding	3
13.	EET-756	Telecommunication Switching Systems	3
14.	EET-765	Radio Frequency Engineering	3
15.	CSC-704	Advanced Cryptography	3
16.	CSC-708	Advanced Simulation and Modeling	3
17.	CSC-709	Detection and Estimation Theory	3
18.	CSC-757	IP Multimedia System	3
19.	EET-702	Advanced Network Security	3
20.	ISC-748	Blockchain Technology	3
21.	EET 752	IoT ARCHITECTURE AND PROTOCOLS	3
22.	EET 753	PRIVACY AND SECURITY IN IoT	3

Computer and Network Security	
Course Code:	ISC-512
Pre-Requisite:	None
Objectives	The course will provide an optimal description of the concepts, methods, principles and applications of computer network security in particular, and cyberspace security in general. The understanding give awareness regarding security situations based on a constant security threat, the core and best practices their solutions currently in use. It is an essential security course for students, practitioners in networks, and professionals who develop and maintain secure computer network systems.
Contents	Computer and network security essentials, Network Security: security attacks, TCP/IP & OSI model, security services, threats in networks, security in networks, data security, integrity measures, message authentication code, user authentication, basics of symmetric and public key cryptosystems, transport level security, SSL, TLS, HTTPS, network security measures: firewalls and IDS, ACLs and capabilities, Access control models, Computer Security: Programming-Language Security, Buffer-overflow attacks, defenses and counterattacks, SQL injection, web security (XSS/CSRF attacks), Web attacks and defenses, Privacy/Anonymity: Database privacy.
Text Books:	Guide to Computer Network Security 3 rd edition, Joseph Migga Kizza ,Springer, 2018. Elementary Information Security 2 nd edition, Richard E. Smith, 2017, ISBN: 978-1284055931
Reference Books:	Network Security: The Complete Reference, McGraw Hill Professional, 2015. Guide to Computer Network Security <i>Computer Communications and Networks</i> Kizza, Joseph Migga, Springer, 2015, ISBN 978-0-387-25228-5 Security in Computing, Fourth Edition, Charles P. Pfleeger and Shari

	P. Pfleeger, Pearson Education, 2011
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Mobile Communication and Networking	
Course Code:	EE5-556
Credit Hours:	3+0
Prerequisites:	
Objectives:	<p>Through a series of intensive lectures the course aims to:</p> <ul style="list-style-type: none"> - Understand the basics of Mobile communications & the use of wireless technologies in telecom industry. - To understand basic wireless channel models and implement the functionality of wireless systems. - To have a comprehensive knowledge of cellular mobile technologies

	<p>in different applications.</p> <p>- To learn the latest and future mobile and wireless technologies and their applications in everyday life.</p>
Course outline:	<p>This postgraduate course provides an in-depth study of principles, architectures, protocols, and modeling techniques for mobile wireless networks. The course aims at equipping postgraduate students with not only a solid foundation and the state-of-the-art knowledge in a wide spectrum of wireless communications techniques and protocols, but also the rigorous analytical capabilities to evaluate the performance of complex mobile wireless systems and networks. As a research-oriented class, this course will also introduce students to the emerging and hot topics in mobile wireless networking and mobile computing research. The course will start with an introduction of the fundamental architectures and principles of mobile and wireless networks and their relationships with the backbone Internet. This is followed by the detailed examinations of a number of most recently developed mobile wireless networking technologies and architectures. Several types of widely employed mobile wireless networks and research topics are investigated in-depth as the further applications of the newly developed wireless networking techniques. The course material consists primarily of the classic and recent technical papers published on major wireless/wired networking journal and conferences and the referenced (recommended, but not required) text books. The course also aims at introducing new graduate students to research, as well as exploits potential topics for MS comprehensive projects and PhD research directions.</p>
Resources:	<p>Classic and Recent selected research papers and the referenced (recommended but not required) text books are as follows:</p> <p>Emerging Wireless Communication and Network Technologies: Principle, Paradigm and Performance 1st ed. 2018 Edition by Karm Veer Arya (Editor), Robin Singh Bhadoria (Editor), Narendra S. Chaudhari (Editor)</p> <p>Stallings, Wireless Communications and Networks, Prentice Hall</p> <p>Gordon L. Stüber: “Principles of Mobile Communication”, Kluwer Academic Publishers, Third edition 2012.</p> <p>Lee, William C. Y., Mobile Communication Engineering</p> <p>Parsons, J.D., Mobil Radio Propagation Channel</p>

Digital Communication System	
Course Code:	EET-511
Credit Hours:	3+0
Prerequisites:	Signal and System, Communication system
Objectives:	This course provides extensive knowledge to students about digital communication i.e. coding, correlation, modulation and demodulation, system design, interference and much more about mobile, fixed and satellite communication systems.
Course outline:	Introduction to Digital communications, signal and spectra, baseband modulation, baseband demodulation, bandpass modulation and demodulation, channel coding, source coding
Resources:	<p>Digital Communications, John. G. Proakis, McGraw-Hill, 5th edition, 2008.</p> <p>Digital Communications: Pearson New International Edition: Fundamentals and Applications, Bernard Sklar, 2013.</p> <p>Digital Communication, Barry, John R., Lee, Edward A., Messerschmitt, David G, third edition 2004.</p> <p>Communications Systems, J.S.Chitode, 2014.</p>

Distributed Networking	
Course Code:	EE-519
Credit Hours:	3+0
Prerequisites:	Advance Networking
Objectives:	This course is design to teach how distributed systems are designed and implemented in real systems and provides detail on topics like communication, replication, fault systems, tolerance, and security.
Course outline:	Introduction to distributed systems, Consistency and replication, Fault tolerance and security, Middleware models, Object-based systems, Document-based systems, Distributed file systems and coordination-based systems, Recent Internet and Web protocols, Caching and replication,
Resources:	<p>Tanenbaum, Andrew S., and Maarten Van Steen. <i>Distributed systems: principles and paradigms</i>. Prentice-Hall, 2007.</p> <p>Culler, David, Jaswinder Pal Singh, and Anoop Gupta. <i>Parallel computer architecture: a hardware/software approach</i>. Gulf Professional Publishing, 1999.</p> <p>Coulouris, George F. "Distributed systems: concepts and design/George Coulouris...[et al.]." (2012).</p>

Network Administration and Management	
Course Code:	EET-520
Credit Hours:	3+0
Prerequisites:	Computer Networks
Objectives:	The objectives of the course are to give an insight into the network management concepts and implementation of these concepts.
Course outline:	The Scope of Systems and Network Administration, System Components and their Management, Operating Systems: Windows and Unix Variants, includes File Systems and Standards (UFS, NFS, NTFS), Processes and Job Control, Privileged, User and Group Accounts, Logs and Audits, Systems Performance Tuning, Privileged, User and Group Accounts, Logs and Audits, Systems Performance Tuning, Booting and Shutting down of an Operating System, Formatting, Partitioning and Building a File System, File System Layout, Concept of swap space, Cloning Systems, Process Management and Monitoring;(Scheduling Processes, Killing/Stopping processes, Restarting a Process, Monitoring Process Activity, Maintaining Log Files, File System Repair, Backup and Restoration, Introduction to Network Administration Approaches, TCP/IP Protocol Stack, Addressing and Subnetting : Fixed Vs Variable Masks, VLAN Principles and Configuration, Routing Concepts;(Static and Dynamic Routing, Routing Protocols: RIP, OSPF, BGP,
Resources:	<p>Limoncelli, Thomas A., Christina J. Hogan, and Strata R. Chalup. <i>The practice of system and network administration</i>. Pearson Education, 2007.</p> <p>Hunt, Craig. <i>TCP/IP network administration</i>. Vol. 2. " O'Reilly Media, Inc.", 2002.</p>

Research Methodology	
Course Code:	ESC-701
Credit Hours:	3+0
Prerequisites:	None
Objectives:	This course is aimed at providing the students with an ability to undertake postgraduate level research and an appreciation of relevant ethical and professional issues. After completing this course, students will be able to: Formulate research questions and carry out research investigations, Identify various sources of information and critically analyze the collected information, Identify and apply appropriate research methods in order to plan, conduct and evaluate their research, Effectively report/publish the results of research activities and Develop and deliver presentations to disseminate research findings.
Course outline:	Introduction to research, Qualitative and Quantitative research, The scientific method of research, Choosing a research problem, Choosing a research advisor, Literature Review – Conducting and writing,

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	Formulating the research question, Identifying variables and generating hypothesis, Research Design/Methodology, Information gathering and data collection, Data representation, analysis and interpretation, Writing a research proposal, Ethics of research – Plagiarism and Intellectual property rights, Organizing and managing conferences and workshops, Writing research papers/Reviewing research papers, Planning and delivering scientific presentations, Writing thesis/dissertations
Resources:	<p><i>Research Methodologies – A step by step guide for beginners</i>, Ranjit Kumar, fifth edition 2019.</p> <p>Research Design: Qualitative, Quantitative, and Mixed Methods Approaches Fifth Edition by John W. Creswell (Author), J. David Creswell (Author), 2018</p> <p><i>How to Research</i>, L. Blaxter, C. Hughes, M. Tight, 4th Edition, 2010.</p>

Advanced Computer Networks	
Course Code:	EET-710
Credit Hours:	3+0
Prerequisites:	Computer Networks
Objectives:	Study of the advanced broadband network technologies and protocols i.e. SONET/SDH, ATM, VoIP, MPLS, GMPLS xDSL, WLL etc., the services that are provided by those technologies
Course outline:	Principles of broadband Networks and communication, SONET, IP over SONET, Frame Relay, ATM concepts, services and applications. ATM Standards and technology for local and wide area networks. ATM adaption layer, Access switching, ATM WAN Switches. ATM Service classes, QoS, ISDN technology. VoIP, IP over ATM, xDSL,.
Resources:	<p>Stallings, William. <i>High-speed networks: TCP/IP and ATM design principles</i>. Vol. 172. Englewood Cliffs, NJ: Prentice hall, Latest Edition, 2018.</p> <p>Leon-Garcia, Alberto, and Indra Widjaja. <i>Communication networks</i>. McGraw-Hill, Inc., 2016.</p>

Communication System Analysis and Design	
Course Code:	EET-523
Credit Hours:	3+0
Prerequisites:	None
Objectives:	<p>Emphasize on communication system modeling</p> <p>Theoretical as well as Practical expertise over communication system designing.</p> <p>Analyze the various challenges of communication system.</p>
Course outline:	<p>Introduction to communication system</p> <p>Mathematical communication channel modeling</p> <p>Deterministic and Random signal Analysis</p> <p>Oscillators, PLL, Frequency Synthesizer</p> <p>Designing and analyzing Radio transmitters</p> <p>Communication Receivers</p> <p>Microwave Techniques</p> <p>Satellite communication system Designing</p> <p>Fiber optic system designing</p> <p>Communication Link Analysis</p>
Resources:	<p>Electronic Communications system by Davis. Kennedy, 3rd Edition.</p> <p>Wayne, Tomasi. "Electronic Communications Systems Fundamentals Through Advanced." (2003).</p>

Advance Satellite Communications	
Course Code:	EET-549
Credit Hours:	3+0
Prerequisites:	Digital Communication Systems & Wireless Communications
Objectives:	<p>Satellite technology has progressed tremendously over the last 50 years since Arthur C. Clarke first proposed the idea in his article titled “Extra-terrestrial Relays” in the magazine Wireless World describing fundamentals behind the deployment of artificial satellites in geostationary orbits for the purpose of relaying radio signal. Arthur C. Clarke is often quoted as the inventor of the communications satellites. Since then, satellite systems have been providing variety of services including broadband communications, audio/video distribution networks, maritime navigation, worldwide customer support as well as military command and control. Satellite systems are also expected to play an important role in the emerging 4G global infrastructure providing the wide area coverage necessary for ubiquitous computing applications in the near future.</p>
Course outline:	<p>Introduction to satellite communication systems</p> <p>Satellite components (payload, orbital maneuvering systems, etc.) and look angle predictions Multiple access techniques is satellite</p> <p>Satellite propagation environment & issues</p> <p>Modulation and coding in satellite communications</p> <p>Elements of VSAT systems and link budgeting</p> <p>Non-geostationary satellite systems and DBS services</p>
Resources:	<p>“Satellite Communications”, Dennis Roddy, 4th Edition, McGraw-Hill, 2006</p> <p>“The Satellite Communication Applications Handbook” Bruce R. Elbert, 2nd Edition, Artech House Publishers, 2004.</p>

Telecommunication Network management	
Course Code:	EET-560
Credit Hours:	3+0
Prerequisites:	Basics of Telecom
Objectives:	This course has been designed for the students having different types of backgrounds such as BSCS, BSSE BSCE, BE (Electrical) and BE (Telecom) to study and understand how telecom networks are management. It includes studying different protocols e.g. SNMP. It is assumed that students are having fundamental concepts/knowledge of different types of telecommunications networks such as Telephony Networks, IP and Data Networks etc.
Course outline:	Fundamentals of Telecommunications Types of Networks Telecommunication Network Management Network Design Network Performance Functions of Network Management Systems Fault Management Telephone Systems Management Management through Network Dimensioning techniques SNMP/HP/CORBA Congestion Control, Quality of Service
Resources:	Fundamentals of Telecommunications Network Management By Lakshmi G. Raman OSS for telecom Networks : An introduction to Network management by Kundan Misra

DSP Applications in Telecommunications	
Course Code:	EET-703
Credit Hours:	3+0
Prerequisites:	Digital signal Processing
Objectives:	The course aims at introducing the students with the application of Digital Signal Processing in the telecommunication industry and its related concepts
Course outline:	IIR Filter Design, Impulse Invariance method, Bilinear Transformation (BLT) method , Comparison with FIR Filter Design, Windows, Kaiser method, Computer-based Digital Filter design, Real-time implementation of Digital filters on Texas Instruments' DSK board TMS320C6x, Decimation, Interpolation, Sampling rate conversion, Telecom Applications like Design of phase shifters ,Digital filter banks, Sub-band Coding of speech signals, Transmultiplexers, Forward Linear prediction, Backward Linear prediction, AR, ARMA processes, Wiener filters, Speech recognition and Synthesis, Speech modeling and Quantization, Digital audio basics, Oversampling and Multirate processing, Dithering and Companding, Hi-Fi Audio, Digital FM Stereo generation, Spread spectrum Communication, Modem, GSM handset
Resources:	Shenoi, Kishan. <i>Digital signal processing in Telecommunications</i> . Prentice-Hall, Inc., 1995.

Broadband Technologies and Components	
Course Code:	EET-705
Credit Hours:	3+0
Prerequisites:	None
Objectives:	This module introduces the technologies involved in the design and construction of transport networks (wireless, copper and optical) and the applications areas in which they are used. It covers the physical fundamentals of the generation, guided transmission, amplification and reception of light, the design consideration and techniques used in radio networks, the principles of digital transmission and the role of optics and wireless in both access and core networks.
Course outline:	Principles of Digital Transmission Optical Fibre Principles Principles of Photon Generation and Reception Optical Amplification and Wavelength Division Multiplexing Design of Optical Links Optical Networking Radio Propagation

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	<p>Radio System concepts</p> <p>Microwave Transmission systems</p>
Resources:	<p>Broadband Planar Antennas: Design and Applications Feb 3, 2006</p> <p>by Zhi Ning Chen and Michael Yan Wah Chia</p> <p>Akujuobi, Cajetan M., and Matthew NO Sadiku. <i>Introduction to broadband communication systems</i>. Chapman and Hall/CRC, 2007.</p> <p>Guided Wave Optical Components and Devices: Basics, Technology by Bishnu P. Pal – Latest Edition</p>

Advanced Optical Fiber Networks	
Course Code:	EET-706
Credit Hours:	3+0
Prerequisites:	Physics

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Objectives:	The course will provide an understanding of the theory of optics and its application in the transmission of data along the cabling, This course provides a background in fiber optics systems so that engineers will be able to utilize fiber optics in field.
Course outline:	Introduction and overview of current developments in Optical Communication Networks. Types of optical fiber, Waveguide phenomenon, Optical fiber losses (Attenuation, Dispersion), Type of advance fiber, Light Sources, Receiver and its characteristics, Optical Amplifiers, Link budget calculation, Dense Wavelength Multiplexing (DWDM), Standards for Advanced Optical Networks, emerging technology, OPNET/ VPI simulation and software tool
Resources:	<p>Ramaswami, Rajiv, Kumar Sivarajan, and Galen Sasaki. <i>Optical networks: a practical perspective</i>. Morgan Kaufmann, Latest edition.</p> <p>Ho, Pin-Han, Hussein T. Mouftah, and Jing Wu. "A novel design of optical cross-connects with multi-granularity provisioning support for the next-generation internet." <i>IEEE International Conference on Communications, 2003. ICC'03..</i> Vol. 1. IEEE, 2003.</p> <p>Keiser, Gerd. "Optical fiber communications." <i>Wiley Encyclopedia of Telecommunications</i> (2003).</p>

Telecommunication Business Environment	
Course Code:	EET-707
Credit Hours:	3+0
Prerequisites:	None
Objectives:	The objectives of the TBE module are for students to gain an appreciation of the external environment within which a telecommunications business operates and how a company can successfully conduct business in this environment. Two perspectives are therefore taken: scene setting descriptions of the macro-economic and regulatory environment of today (focusing on the Pakistani, but with a global view also); coupled with an introduction to the management of a telecommunications business.
Course outline:	<p>Introduction to Telecommunications & ICT Business</p> <p>Business Strategic Drivers</p> <p>The Regulatory and Legal Scene</p> <p>Review of the Industry</p> <p>Business Cases</p> <p>Financial Management</p>
Resources:	<p>Media, Telecommunications, and Business Strategy by Richard A. Gershon – Latest Edition</p> <p>Telecommunications and Business Strategy by Richard A. Gershon - Feb 2008</p> <p>Marketing Telecommunications Services : New Approaches for a Changing Environment by Karen G Strouse - 1999</p>

Network Planning and Evaluation	
Course Code:	EET-718
Credit Hours:	3+0
Prerequisites:	None
Objectives:	This module investigates how a large scale multi-purpose communication network can be planned and installed. The evolution of such networks from legacy PSTN to an NGN IP multi-service networks for the 21st century will be examined from the point of view of both core and access in a fixed and mobile environment. The roles of forecasting and traffic dimensioning are examined. Also investigated are the relationships between cost, network planning, dimensioning, network performance and the quality of service perceived by the users.
Course outline:	Introduction to Teletraffic & Networks , Network Strategy & Planning Forecasting, Access Network Planning , Access Network Evolution , Core Transport Planning , Network & Market Trends , Mobile Network Planning, Network Intelligence & service planning, Data Network Planning , Next Generation Networks (NGN) , Network Performance Planning
Resources:	Sheridan, Patrick F., and J. A. Weitzen. "Evaluation of network planning and design for corporate internetworks." <i>IEEE Network</i> 3.6 (1989): 11-14. Performance Evaluation and Planning Methods for the Next Generation by Andre Girard, Brunilde Sansò, Felida Vazquez-Abad – Latest Edition WiMAX Network Planning and Optimization - by Yan Zhang – Latest Edition

Antenna and Microwave Engineering	
Course Code:	EET-751
Credit Hours:	3+0
Prerequisites:	Communication system
Objectives:	This course provides students with comprehensive coverage of a wide variety of antenna and propagation topics related to numerous communication systems.
Course outline:	<p>Fundamental Antenna Concepts</p> <p>Material and Design Data</p> <p>Types of Antennas</p> <p>Fundamental Antenna Elements</p> <p>Advanced Antenna Elements</p> <p>Passive and Active Antenna Arrays</p> <p>Electrically Small Antennas</p> <p>The Propagation Channel and Practical Antenna Implementation</p> <p>Phased Arrays</p> <p>Cellular Antennas</p> <p>Antenna Measurements</p>
Resources:	<p>Collin R.E., 'Antennas and Radiowave Propagation', Mc.Graw Hill, Latest Edition</p> <p>Balanis, C. A., 'Antenna Theory, Analysis and Design', Harper and Row Publishers, Latest Edition</p>

Information Theory and Coding	
Course Code:	EET-553
Credit Hours:	3+0
Prerequisites:	Basic probability and linear algebra as well as a minimum of mathematical maturity are the only prerequisites. An introduction to what computer scientists mean by "information", including topics in data compression (such as zip files and mp3), error correcting codes, information entropy, cryptography, and randomness. This is an intermediate course in computer science, and as such requires some background in programming as well as math through at least pre-calculus.
Objectives:	This course presents the fundamentals of Information Theory, that stays at the basis of modern digital communications, data compression, lossy source coding and multiuser networks.
Course outline:	Asymptotic Equipartition Theorem, types, and typical sequences, Information measures and their properties: entropy, Kullback-Leibler divergence, mutual information, source coding theorem, channel coding theorem, rate distortion theory, quantization, maximum entropy principle Typical sequences and typical sets, error exponents in: hypothesis testing, source coding, and channel coding, information theory and estimation, rudiments of network information theory.
Resources:	<p>T.M. Cover and J.A. Thomas, Elements of Information Theory, Wiley, Latest Edition ;</p> <p>I. Csisz`ar and J. K`orner, Information theory: coding theorems for discrete memoryless systems, Cambridge University Press, Latest Edition.</p> <p>Codes: an introduction to information communication and cryptography by Norman Biggs, 2008</p>

Telecommunication Switching Systems	
Course Code:	EET-756
Credit Hours:	3
Prerequisites:	
Objectives:	<p>To learn basics of switching systems and design of different switching systems.</p> <p>To understand and designing of multistage networks</p> <p>To understand different switching systems such as electronic space division switching and time division switching</p> <p>To understand different signaling techniques and networks and topologies.</p> <p>To understand different networks, charging and routing plans.</p> <p>6. To understand the overall data communication and switching networks.</p>
Course outline:	<p>This course provides the conceptual fundamentals of telecommunication systems. It is designed to familiarize students with practical aspects of telecommunication system range from traditional wired & wireless systems. Students are also introduced with working and designed principles of SSN7. Multiplexing and multiple access schemes are also covered in detail: Basic Telephony; Digital Transmission Systems; Switching System, Electronic Space Division, Multiplexed Switching, Switching in LAN, Grade of Service, Synchronization, Control of Switching System, Call Processing Function, Channel Associated Signaling, Signaling System-7 (SS7), Telecommunications Traffic and models Numbering Plans, SONET, WLAN, Transmissions and switching techniques for various telecommunication Networks.</p>
Resources:	<p>Telecommunication Switching Systems and Networks by Thiagarajan Viswanathan and Gleaner Co. 2015</p> <p>Telecommunication Switching Systems and Networks by V.S.Bagad – 2009</p>

	<p>Telecommunication Switching And Networks by P. Gnanasivam – 2007</p> <p>Routing and Switching Essentials Lab Manual by Cisco Networking Academy 2013.</p>
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Radio Frequency Engineering	
Course Code:	EET-765
Credit Hours:	3+0
Prerequisites:	Communication system
Objectives:	The course aims to introduce with radio frequency concepts and their implementation in communication system, Radio frequency engineering gives the knowledge of smith chart, impedance matching etc
Course outline:	RF Overview (RF history, Basic building blocks in cellular, modulation schemes, signal variations, propagation models, fading characteristics, Types of Propagation Models (point-to-point model), Okumura-Hata model, Cost-231 model, microcell models. Antennas (Antenna basics, EIRP concept, Antenna parameters, radiation patterns, Antenna types & impact on system performance, etc.), Optimization philosophy (Basic optimization procedures, Air interface and network, System Design (Pre-implementation design issues, Eb/No Vs, SNR, receiver sensitivity, noise figure, dynamic range)
Resources:	<p>Foundation of Mobile Radio Engineering, Michel Daoud Yacoub, Latest Edition</p> <p>Microwave and RF Engineering, R. Sorrentino, Giovanni Bianchi, JohnWiley & sons, 2010.</p>

Advanced Cryptography	
Course Code:	CSC-704
Credit Hours:	3+0
Prerequisites:	Data Encryption and Security
Objectives:	On one hand, quantum computing promises new cryptanalytic tools on existing one-way functions (Shor's algorithms), but on the other hand, quantum cryptography promises perfect key distribution. The purpose is to bring the student to understanding of the current issues in the fast evolving world of cryptography.
Course outline:	Cryptography has evolved significantly since the introduction of one-way functions for public-key cryptography and digital signatures in the 1970's. A number of new interests were born from relations between cryptography and complexity theory: interactive proofs, zero-knowledge protocols, multi-party computing, etc. Another great change in the world of cryptography is currently unveiling itself: the impact of quantum computing/information processing on cryptography.
Resources:	<p>Practical Cryptography, by Niels Ferguson, Bruce Schneier. Wiley Publishing, Latest Edition.</p> <p>Applied Cryptography: Protocols, Algorithms, and Source Code in C, Second Edition, John Wiley and Sons, Latest Edition.</p>

Advanced Simulation and Modeling	
Course Code:	CSC-708
Credit Hours:	3+0
Prerequisites:	Stochastic Process
Objectives:	The course will provide mathematical and probabilistic basis for system modeling and also provide a platform for simulation of various protocols.
Course outline:	Introduction to Probability theory, Random variables, commonly used continuous and discrete distributions. Introduction to Stochastic Process, Poisson process, Markov chains, steady state and transient analysis. Pseudo random numbers: Methods of Generation and testing. Methods for generating continuous and discrete distributions. Methods for generating Poisson Process. Building blocks of Simulation, Data Structures and Algorithms. Introduction to Probabilistic modelling, Maximum Likelihood Variance reduction techniques: antithetic variates, control variates, common random numbers, importance sampling. Analysis of Simulation results: confidence intervals, design of experiments Markov Chain Monte Carlo techniques
Resources:	Sheldon M. Ross: Introduction to Probability Models 12th Edition, Academic Press, 2019 Donald E. Knuth: The Art of Computer Programming - Volume 2: Semi Numerical Algorithms,

Detection and Estimation Theory	
Course Code:	CTN-799
Credit Hours:	3+0
Prerequisites:	DSP
Objectives:	The theory of optimal parameter estimation, properties of estimation and tools for analysis of the efficacy of parameters will also be taught. Students will learn to design and analyze optimal and sub-optimal detection and estimation algorithms under realistic.
Course outline:	Bayesian Hypothesis Testing, Minimax Hypothesis Testing, Neyman-Pearson Hypothesis Testing, Composite Hypothesis Testing, Deterministic Signals, Stochastic Signals, Chernoff Bounds, Bayesian Parameter Estimation, Minimum-Variance Unbiased Estimators, Cramer-Rao bounds, Least-square estimates, Expectation Maximization (EM) algorithm, Wiener filters, Kalman filters,
Resources:	<p>H. Vincent Poor, Signal Detection and Estimation, Springer, Latest Edition</p> <p>M.D. Srinath, P.K.Rajasekaran, R. Viswanathan, Introduction to Statistical Signal Processing with Applications, Prentice-Hall, Latest Edition</p> <p>S.M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall, Latest Edition</p>

IP Multimedia System	
Course Code:	CSC-757
Credit Hours:	3+0
Prerequisites:	None
Objectives:	<p>The course begins with a summary of the fundamentals of analogue and digital transmission of multimedia. It then goes into specific aspects of services for media transport over IP, IPTV, middleware for multimedia transport, and interactive multimedia services. Specific topics such as: MPEG coding formats and applications, multimedia-enabled devices, streaming systems and</p>

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	infrastructure support, etc., are covered in depth.
Course outline:	<p>Fundamentals of analogue and digital multimedia transmission</p> <p>MPEG formats for media coding and transport</p> <p>Services and transport over IP</p> <p>IPTV</p> <p>Middleware for multimedia support over heterogeneous networks and devices</p> <p>Experimentation with real-time video streaming systems</p>
Resources:	<p>Design and Analysis of IP Multimedia Subsystem (IMS) by Anis Aziz, Wagdy (Author), 2017</p> <p>Multimedia over IP and Wireless Networks: Compression, Networking, and Systems by Mihaela van der Schaar and Philip A Chou – 2007</p> <p>IP Multimedia Subsystem Complete Certification Kit - Study Book and eLearning Program - 2016 - by Erik Landry</p>

Advanced Network Security	
Course Code:	EET-702
Credit Hours:	3+0
Prerequisites:	
Objectives:	<p>The objectives of this course are:</p> <p>To teach significance and impact of different network security attacks</p> <p>To study data confidentiality techniques used in communication networks (Advanced encryption techniques)</p> <p>To study data integrity techniques</p> <p>To study different authentication schemes</p> <p>Layer-wise study of different network security protocols and techniques</p>
Course outline:	<p>Understand computer and network security related threats, attacks and their countermeasures</p> <p>Analyze and understand the operation of various practical encryption schemes</p> <p>Understand how data integrity schemes operate</p> <p>Understand how data and user authentication is carried out in communication networks</p> <p>Understand the operation of network security protocols used over the internet</p>
Resources:	<p>Cryptography and Network Security, William Stallings, Seventh Edition, Pearson Education, 2016.</p> <p>Security in Computing, Charles P. Pfleeger and Shari P. Pfleeger, Fifth Edition, Pearson Education, 2018</p>

Blockchain Technology	
Course Code:	ISC-748
Credit Hours:	3+0
Prerequisites:	NIL
Objectives:	<p>Many people find it difficult to understand blockchain because it requires the coordination of many components for it to function, and it's hard to see the full picture until all the individual components are fully understood. Furthermore, since the field is very technical and relatively new, blockchain-related discussion by nature is full of jargon. Therefore, it is easy to get lost trying to follow nearly any conversation on blockchain if you have not built up the right background.</p> <p>Therefore, the goal of this course is to surmount the steep learning curve of blockchain. By the end of this course the student will understand how blockchain works and the ideas, technologies, and organizations sprouting from it.</p>
Course outline:	<p>Bitcoin Protocol and Consensus: A High Level Overview, Bitcoin and Blockchain History: From the Cypherpunk Movement to JPMorgan Chase, Bitcoin Mechanics and Optimizations: A Technical Overview, Bitcoin IRL: Wallets, Mining, and More, Ethereum & Smart Contracts: Enabling a Decentralized Future, Game Theory and Network Attacks: How to Destroy Bitcoin, Cryptoeconomics and Proof-of-State, Distributed Systems and Alternative Consensus, Scaling Blockchain: Cryptocurrencies for the Masses, Enterprise Blockchain: Real-World Applications, Anonymity: Mixing and Altcoins, Blockchain Hype and the Future.</p>
Resources:	<p>Bitcoin and Cryptocurrency Technologies (Princeton textbook) by Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller, and Steven Goldfeder, 2016.</p>

IoT ARCHITECTURE AND PROTOCOLS	
Course Code:	EET 752
Credit Hours:	3+0
Prerequisites:	NIL
Objectives:	<p>To Understand the Architectural Overview of IoT</p> <p>To Understand the IoT Reference Architecture and Real World Design Constraints</p> <p>To Understand the various IoT Protocols (Datalink, Network, Transport, Session, Service)</p>
Course outline:	<p>UNIT I – OVERVIEW</p> <p>IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Devices and gateways, Local and wide area networking, Data management, Business processes in IoT, Everything as a Service (XaaS), M2M and IoT Analytics, Knowledge Management</p> <p>UNIT II – REFERENCE ARCHITECTURE</p> <p>IoT Architecture-State of the Art – Introduction, State of the art, Reference Model and architecture, IoT reference Model - IoT Reference Architecture- Introduction, Functional View, Information View,</p>

	<p>Deployment and Operational View, Other Relevant architectural views. Real-World Design Constraints- Introduction, Technical Design constraints-hardware is popular again, Data representation and visualization, Interaction and remote control.</p> <p>UNIT III – IOT DATA LINK LAYER & NETWORK LAYER PROTOCOLS</p> <p>PHY/MAC Layer (3GPP MTC, IEEE 802.11, IEEE 802.15), Wireless HART, Z-Wave, Bluetooth Low Energy, Zigbee Smart Energy, DASH7 - Network Layer-IPv4, IPv6, 6LoWPAN, 6TiSCH,ND, DHCP, ICMP, RPL, CORPL, CARP</p> <p>UNIT IV – TRANSPORT & SESSION LAYER PROTOCOLS</p> <p>Transport Layer (TCP, MPTCP, UDP, DCCP, SCTP)-(TLS, DTLS) – Session Layer-HTTP, CoAP, XMPP, AMQP, MQTT</p> <p>UNIT V – SERVICE LAYER PROTOCOLS & SECURITY</p> <p>Service Layer -oneM2M, ETSI M2M, OMA, BBF – Security in IoT Protocols – MAC 802.15.4, 6LoWPAN, RPL, Application Layer</p>
Resources:	<ol style="list-style-type: none"> 1. Jan Holler, VlasiosTsiatsis, Catherine Mulligan, Stefan Avesand, StamatisKarnouskos, David Boyle, “From Machine-to-Machine to the Internet of Things: Introduction to a New Age of Intelligence”, 2nd Edition, Academic Press, 2018. 2. Peter Waher, “Learning Internet of Things”, PACKT publishing, BIRMINGHAM – MUMBAI 3. Bernd Scholz-Reiter, Florian Michahelles, “Architecting the Internet of Things”, ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer 4. Daniel Minoli, “Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications”, ISBN: 978-1-118-47347-4, Willy Publications 5. Vijay Madiseti and ArshdeepBahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014. 6. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html

PRIVACY AND SECURITY IN IoT	
Course Code:	EET 753
Credit Hours:	3+0
Prerequisites:	NIL
Objectives:	<p>Ability to understand the Security requirements in IoT.</p> <p>Understand the cryptographic fundamentals for IoT</p> <p>Ability to understand the authentication credentials and access control</p> <p>Understand the various types Trust models and Cloud Security.</p>
Course outline:	<p>UNIT I – INTRODUCTION: SECURING THE INTERNET OF THINGS</p> <p>Security Requirements in IoT Architecture - Security in Enabling Technologies - Security Concerns in IoT Applications. Security Architecture in the Internet of Things - Security Requirements in IoT - Insufficient Authentication/Authorization - Insecure Access Control - Threats to Access Control, Privacy, and Availability - Attacks Specific to IoT. Vulnerabilities – Secrecy and Secret-Key Capacity - Authentication/Authorization for Smart Devices - Transport Encryption – Attack & Fault trees</p> <p>UNIT II- CRYPTOGRAPHIC FUNDAMENTALS FOR IOT</p> <p>Cryptographic primitives and its role in IoT – Encryption and Decryption – Hashes – Digital Signatures – Random number generation – Cipher suites – key management fundamentals – cryptographic controls built into IoT messaging and communication protocols – IoT Node Authentication</p> <p>UNIT III- IDENTITY & ACCESS MANAGEMENT SOLUTIONS FOR IOT</p> <p>Identity lifecycle – authentication credentials – IoT IAM infrastructure – Authorization with Publish / Subscribe schemes – access control</p> <p>UNIT IV- PRIVACY PRESERVATION AND TRUST MODELS FOR IOT</p> <p>Concerns in data dissemination – Lightweight and robust schemes for</p>

	<p>Privacy protection – Trust and Trust models for IoT – self-organizing Things - Preventing unauthorized access.</p> <p>UNIT V - CLOUD SECURITY FOR IOT</p> <p>Cloud services and IoT – offerings related to IoT from cloud service providers – Cloud IoT security controls – An enterpriseIoT cloud security architecture – New directions in cloud enabled IoT computing</p>
Resources:	<p>1. Practical Internet of Things Security (Kindle Edition) by Brian Russell, Drew Van Duren, June 2016</p> <p>2. Securing the Internet of Things Elsevier, 1st Edition, January 2017</p> <p>3. Security and Privacy in Internet of Things (IoTs): Models, Algorithms, and Implementations, April 2016.</p>

BS (Computer Science)

Vision

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

Mission

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

Objectives

1. To provide an understanding of the fundamental concepts of Computer Science.
2. To enrich the students with modern tools and technologies with respect to an ever changing business and technological environment.
3. To provide mathematical and logical skills critical for solving computing problems.
4. To develop skills in order to collaborate effectively through written and oral communication.
5. To develop effective team working/leading skills.
6. To enable students to utilize best ethical, communication and computing skills in acquiring jobs or higher studies.

BSCS Program Outcomes

Students will be able to:

1. Analyze computing problems and design solutions using mathematical and computing foundations.
2. Able to adapt modern tools and technologies to an ever changing professional environment.
3. Demonstrate teamwork and leadership skills through group activities and projects in a professional world.

BS (Information Technology)

Vision

To become the hub of quality, technically advanced, globally competitive and socially active information technology education.

Mission

To produce graduates having problem solving and management skills and know how to generate IT solutions along with team building and professional skills.

Objectives

1. To enable students to analyze and evaluate various effective software systems in management and business.
2. To provide IT education for individuals who are motivated to acquire new technical and scientific skills in this discipline.
3. To build analytical skills for solving IT problems in a given business and social environment.
4. To inculcate entrepreneurial attitudes in students employing quality skills of s/w development and effective communication.
5. To develop effective team working/leading skills.

6. To enable students to be an IT professional with ethical behavior and produce solutions keeping in view the impact of technology on society.

BSIT Program Outcomes

Students will be able to:

1. Identify IT problems and evaluate solutions with respect to organizational and business requirements.
2. Design IT solutions for business problems that meet the organizational, business and societal requirements.
3. Understand professional, ethical, legal, security and social issues and responsibilities in IT context.
4. Demonstrate teamwork and leadership skills through effective decision making and communication skills.