POST GRADUATE STUDIES

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

141-142 LOVE ROAD, TEJGAON INDUSTRIAL AREA
DHAKA-1208, BANGLADESH

Published by

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Ahsanullah University of Science and Technology
141-142 Love Road, Tejgaon Industrial Area,
Dhaka-1208, Bangladesh

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The information contained in this bulletin is intended to provide guidance to those who are concerned with undergraduate studies in Electrical and Electronic Engineering. No responsibility will be borne by the Department of Electrical and Electronic Engineering and/or the Ahsanullah University of Science and Technology if any inconvenience or expenditure is caused to any person because of the information in this bulletin. Also the information contained in it is subject to change at any time without any prior notification.

The University

The Ahsanullah University of Science and Technology (AUST) was founded by the Dhaka Ahsania Mission in 1995 as per permission accorded by the Ministry of Education, People's Republic of Bangladesh and the University Grants Commission, Bangladesh. The university aims to provide ambitious students with quality education to meet the needs of our society in the perspective of highly competitive and globalized world. Bachelor degree programs in eight disciplines are being conducted under three faculties – Faculty of Architecture and Planning, Faculty of Business and Social Science and Faculty of Engineering, while master degree programs are being conducted under the Faculty of Engineering, the Faculty of Business and Social Science and the Faculty of Education. Degrees of the university are recognized by the Government, the Public Service Commission and employers at home and abroad. At present the university is acknowledged as one the leading private universities in Bangladesh. The newly-built spacious permanent campus of the university consisting of a picturesque 10-storied building with a total floor area of more than four lac square feet over five bighas of land is located in the heart of Dhaka city.

A number of memorandum of understandings have been signed between the Ahsanullah University of Science and Technology and (i) the University of Wyoming, USA, (ii) the Drexel University, USA, (iii) the Washington State University, USA, (iv) the University of Houston, Texas, USA, (v) University of Michigan, USA, (vi) AIT, Bangkok (in process), and (vii) Dublin City University (in process) so that the students of this university have the opportunity for further study with transfer of credits.

Department of Electrical and Electronic Engineering

The Department of Electrical and Electronic Engineering of Ahsanullah University of Science and Technology (AUST) is offering a four-year undergraduate degree program since the establishment of AUST in the year 1995. The degree program is spread over eight semesters with two semesters per academic year. The present intake of the students per academic year is 350 students. The class size has been limited to 50 students in the interest of effective teaching. There are now about 1200 students studying in the department. Twenty one batches of students have graduated and are employed in different technical organizations in home and abroad.

There are now 53 full time teachers of the department together with about 10 part time teachers. Most of the part time teachers are senior teachers of Bangladesh University of Engineering and Technology (BUET).

The aim of engineering education is to impart to the students up-to-date theoretical and practical knowledge of the particular branch of engineering. Consequently the undergraduate courses offered to the students have been designed considering the courses offered in BUET and some foreign universities, keeping in view the ever-increasing horizon of Electrical and Electronic Engineering. It may be mentioned here that a number of students of EEE Department of AUST got transferred to US Universities with credit transfer of courses taken at AUST.

The department has already developed its own laboratories in such areas as Electrical Circuits, Electronics, Digital Electronics, Electrical Machines, Telecommunications, Control Systems, Switchgear and Protection, Power Systems, Microwaves, Microprocessors, VLSI Design and Digital Signal Processing.

The department favors interaction between University and industry and, in this connection, some of the activities of the department are:

Study tour of students to industry, power stations and telecommunication centers etc.
Seminars: Resource persons are invited to speak on selected topics of interest.
Project display of final year students.

2.1 Course Contents

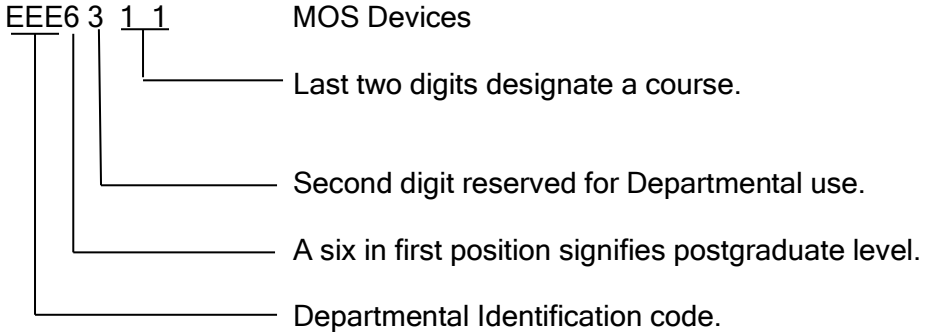
These courses are designed for postgraduate programs leading to the award of postgraduate degrees. Each course is designated by a three letter word identifying the department which offers it following by a four digit number with the following criteria:

a) The first digit will correspond to the postgraduate level .

b) The second digit will be reserved for Departmental use to identify different areas/fields within a department such as Power, Electronics, Communication etc.

c) The last two digits will designate a course.

The course designation system is illustrated by the following example.



2nd digit –'3' means Electronics, –'5' means Power, –'7' means Communication

2.2 Divisions of Specialization and choice of courses at EEE Department:

There shall be a selection committee constituted by the respective BPGS on the recommendation of the Head of the Department.

Before being finally selected for admission, a candidate may be required to appear at an interview by the selection committee as constituted by the BPGS. The Division of Specialization of a post graduate student will be assigned by the selection committee. He/She will be required to take pre-requisite course (s) as may be prescribed by the committee.

There are three divisions of specialization under which a postgraduate student can specialize

- Electronic Division
- Power Division
- Communication Division

courses can be arranged as:

- Electronic Division (EEE 63**series)
- Power Division (EEE 65** series)
- Communication Division (EEE 67** series)
- Interdisciplinary group (EEE 69**series)

2.3 Requirement for the Masters degree in EEE Department:

Requirements for the Degrees

The following are the requirements for the Masters degrees and Postgraduate Diploma:

2.3.1 M. Sc. Engg.

(i) A student must complete at least 18 (eighteen) credit hours of course work with a minimum CGPA of 2.65, and

(ii) He/She must complete a project/thesis work of 18(eighteen) credit hours with a "satisfactory" grade, and fulfilling the procedures and requirements as described in article 8.

(iii) The minimum credit hour requirement as such is 36.

2.3.2 M. Engg.

(i) A student must complete at least 30 (thirty) credit hours of course work with a minimum CGPA of 2.65, and

(ii) He/She must complete a project/dissertation work of 6(six) credit hours with a "satisfactory" grade, and fulfilling the procedures and requirements as described in article 8.

(iii) The minimum credit hour requirement as such is 36.

For the degree of M.Sc. Engg. a student has to take a minimum of 6 courses of which at least four (04) are from his /her assigned Division, and remaining two (02) are from the Interdisciplinary group or any Division. For the degree of M. Engg. a student has to take a minimum of 10 courses of which at least six(06) are from his/ her Division and the remaining four(04) are from the Interdisciplinary group or any Division .

2.4 Project / Thesis, Project /Dissertation & Special Study/Report

2.4.1 Appointment of Supervisor

2.4.1.1 Research work for a project / thesis or project/report or special study/report, as the case may be, shall be carried out under the supervision of a teacher, not below the rank of an Assistant Professor from the respective or from any other department of this university proposed by the Head of the department and accepted by the BPGS. A Joint Supervisor or Co-supervisor (if necessary) may be appointed from within / outside the university recommended by the BPGS. No co-supervisor shall normally be allowed for PG. Diploma project/report or special study/report supervision.

2.4.1.2 In case of selecting a supervisor / Joint Supervisor/ Co-supervisor from other than the respective department, an approval from the Supervisor's Head of the department has to be taken.

2.4.1.3 The Supervisor, Joint Supervisor / Co-supervisor (if any) shall be approved by the CASR on the recommendation of the BPGS.

2.4.1.4 A project/thesis, project/dissertation or project/report supervisor has to be normally appointed after the completion of the first semester of a student.

2.4.2 Research Proposal

A student shall submit a research, project or special study proposal, as the case may be, to BPGS through his/her supervisor (s). For both M. Sc Engg. & M. Engg. degrees, the BPGS shall examine the proposal and recommend it to CASR, through the Head of the Department, for approval. For PG. Diploma, BPGS will follow the similar procedure except that the approval shall be taken from the Vice-Chancellor. The Vice-Chancellor will report this approval to CASR. If any change is required in the approved proposal (title, content, cost, supervisor etc), it shall be approved, by the relevant approving authority on the recommendation of the BPGS.

2.4.3 The research, project or special study work should normally be carried out in the university. However, if necessary, the supervisor can allow his / her student to carry out research work outside the university with the approval of the BPGS. The work schedule and financial involvement should be mentioned in the research proposal for carrying out research work.

2.4.4 At the end of a student's research work on the advice of the supervisor the student shall submit a thesis which must be an original contribution to Engineering and worthy of publication. Every student shall have to submit required number of printed copies of his / her thesis, dissertation or report in the approved format to the Head of the department through his / her supervisor on or before a date to be fixed by the Head of the department in consultation with the supervisor (s).

2.4.5 A student shall have to make a declaration, duly countersigned by the supervisor, that the research or project work has been carried out by him and not submitted elsewhere for any purpose except for publication.

2.4.6 Thesis, Dissertation and Special Study Report Examination

M. Sc. Engg. and M. Engg.

The CASR shall constitute an examination committee for each project / thesis examination and oral examination from the panel of examiners proposed by concerned Head of the department in consultation with the supervisor(s) and recommended by the concerned BPGS. The examination committee shall be as follows:

(i) Supervisor	Chairman
(ii) Joint Supervisor / Co-supervisor (if any)	Member
(iii) Head of the Department	Member
(iv) One or Two Teachers from within the department not below the rank of Assistant Professor	Member
(v) One External Examiner outside the university(preferably holding a postgraduate degree)	Member (External)

2.5 Course List

2.5.1 Electronic Division

For electronics – 4th digit '1' means basic semiconductor related ', '2' means integrated circuit related', '3' means nano-electronics related', '4' means optoelectronics related', '5' means applied electronics related'.

1. **EEE 6301: Compound Semiconductor Devices**
2. **EEE 6311: MOS Devices**
3. **EEE 6321: Semiconductor Device Fabrication**
4. **EEE 6331: Semiconductor Characterization Techniques**
5. **EEE 6341: E & M Properties of Materials**
6. **EEE 6351: Semiconductor Device Modeling and Simulation**
7. **EEE 6361: Semiconductor Material and Heterostructures**
8. **EEE 6302: Advanced VLSI Technology**
9. **EEE 6312: VLSI Devices, Circuits and System Models**
10. **EEE 6322: Analysis and Design of Digital IC**
11. **EEE 6332: CMOS Analog IC Design**
12. **EEE 6342: Radio Frequency Integrated Circuits (RFIC)**
13. **EEE 6303: Nanotechnology & Nano Systems**
14. **EEE 6313: Quantum Mechanics and Nanostructures**
15. **EEE 6323: Thin Film Growth and Deposition**
16. **EEE 6304: Advanced Optoelectronics**
17. **EEE 6314: Laser Theory**
18. **EEE 6324: Solar Cell Technology**
19. **EEE 6334: LCD Technology**
20. **EEE 6305: MEMS Device**
21. **EEE 6315: Microwave Solid State Devices and ICs**
22. **EEE 6325: Power Semiconductor Devices and Circuits**
23. **EEE 6335: System on a Chip Design**
24. **EEE 6345: Superconducting Device**
25. **EEE 6355: Biomedical Electronic Devices**

2.5.2 Power Division

For power – 4th digit '**1' means power system', '2' machines related'**, '3' means energy generation & environment related', **'4' means T &D related'**, '5' means protection related'.

1. **EEE 6501: Computer Method in Power System Analysis**
2. **EEE 6511: Power System Stability**
3. **EEE 6521: Power System Control**
4. **EEE 6531: Modern Power System Modeling**
5. **EEE 6541: Power System Reliability**
6. **EEE 6551: Optimization of Power System Operation**
7. **EEE 6561: Power System Planning**
8. **EEE 6502: Design of Electrical Machines**
9. **EEE 6512: Generalized Machine Theory**

10. EEE 6503: Renewable Energy Resources and Technologies
11. EEE 6513: Environmental Impact of Generation of Electrical Energy
12. EEE 6504: Industrial Electrical Distribution System Planning
13. EEE 6514: Smart Grid Design and Application
14. EEE 6505: Modern Switchgear and Protection

2.5.3 Communication Division

For communication - 4th digit '1' means basic telecommunication related ', '2' means optical communication related', '3' means microwave related', '4' means wireless communication related', '5' means digital communication related', '6' means applied communication related'.

1. EEE 6701: Advanced Telecommunication Engineering
2. EEE 6711: Telecommunication Switching and Queue Systems
3. EEE 6721: Advanced Communication Network Planning and Protocol
4. EEE 6741: Communication Network Planning, Security and Modeling
5. EEE 6702: Advanced Optical Fibre Communication
6. EEE 6712: Optical Networks
7. EEE 6703: Advanced Microwave and RF Engineering
8. EEE 6713: Antennas and Propagation
9. EEE 6723: Numerical Methods in EM Field Computation
10. EEE 6743: EMI and Noise Reduction Techniques
11. EEE 6704: Advanced Wireless Communications
12. EEE 6714 Application of CDMA to Cellular Communications
13. EEE 6724: Digital Satellite Communications
14. EEE 6734: Remote Sensing
15. EEE 6705: Information and Coding Theory
16. EEE 6715: Stochastic Process and Modeling
17. EEE 6725: Theory and Design of Digital Filters
18. EEE 6735: Biomedical Signal Processing
19. EEE 6745 :Digital Speech and Image Signal Processing
20. EEE 6745 :Digital Video Processing
21. EEE 6706:Communication Measurement Techniques

2.5.4 Interdisciplinary Group

For electronics - 4th digit '1' means fundamental topics related ', '2' means non linear system related', '3' means control' , '4' means artificial intelligence related' '5' means biomedical related', '6' means space related'.

1. EEE 6901: Engineering Analysis
2. EEE6911: Nuclear Energy
3. EEE 6902: Nonlinear System Analysis
4. EEE 6912: Nonlinear Control System
5. EEE 6913: Modern Control Theory
6. EEE 6904: Artificial Intelligence System
7. EEE 6914: Embedded System
8. EEE 6905: Advanced Biomedical Measurement
9. EEE 6706: Robotic Systems and Control
10. EEE 6907: Electronic and Communication devices for Space Engineering

2.6 Core Courses

The Department has identified the following courses as core courses. A student is required to take 3 courses from the following list in order to graduate.

EE 6301 Compound Semiconductor Devices (Electronics Group)
EE 6501 Computer Methods in Power System Analysis (Power Group)
EE 6701 Advanced Communications Engineering (Communications Group)
EE 6913 Modern Control Theory (Interdisciplinary Group)

Chapter 3 Course Detail

EEE 6301: Compound Semiconductor Devices
3 Credits

Advanced treatment of semiconductor material with an emphasis on binary compounds, ternary and quaternary alloys, lattice matching and lattice mismatched layers, strained layers, types of strains. Crystal structures, lattice vibrations, energy band structure, direct bandgap and indirect bandgap materials. Introduction to GaAs device technology, GaAs based optoelectronic devices, compounds of GaAs using Al, In, InP. Carrier transport phenomena in GaAs based materials. GaAs metal-semiconductor field effect transistor (GaAs MESFET): introduction, structure, equivalent circuits, current saturation, effect of source and drain resistances, gate resistance and application of GaAs MESFET. High electron mobility transistor (HEMT):practical HEMT structure, energy band line-up, equivalent circuit, HEMT noise, pseudomorphic HEMT and applications. Opto-electronic integration of compound semiconductor devices: heterojunction phototransistor (HPT) and light amplifying optical switch (LAOS). Low-temperature compound semiconductor electronics. Design consideration of MMICs and power MMICs using compound semiconductor devices.Crystalline Si based heterojunction devices, Amorphous Si based heterojunction devices

EEE 6311: MOS Devices
3 Credits
The two terminal MOS Structure: flat-band voltage, inversion, properties of the regions of inversion and small signal capacitance. The four terminal MOS structure: charge-sheet model, strong inversion, moderate inversion and weak inversion. Threshold voltage effect of ion implantation, short channel and narrow width. The MOS transistor in dynamic operation, small signal model for low medium and high frequencies, Charge Coupled devices (CCD). Device Scaling; NMOS, CMOS, BiCMOS Technology, Non classical Si based nano scale CMOS device, SiGeC Avalanced light emitter with CMOS, Device modeling and simulator, large scale MOS Device for Optoelectronics system, wire line and microwave communication.

EEE 6321: Semiconductor Device Fabrication
3 Credits
Introduction to the Fabrication of microelectronic devices, processing technology, device design and layout, Environment for IC fabrication, clean room technology, wafer fabrication and cleaning processes. IC processing steps, ion implantation and diffusion, Front end Process oxidation, Thermal oxidation, First oxidation , Field oxidation, Gate oxidation, Mask preparation, photolithographic techniques, Epitexid growth Technology, Chemical vapour deposition: high and low temperature/pressure depositions, Metallization, Thin Film and Thick film technology, Hybrid circuits, fabrication of circuit elements-diodes, resistors, inductors, contacts and interconnection, Self aligned silicides, Shallow junction formation, Standard bipolar NMOS and CMOS process

sequences, Testing, Bonding, Packaging, Novel structures in bipolar and MOS: VMOS etc. Introduction to process modeling, SUPREM. Statistical methods for semiconductor manufacturing, Embedded softwere based semiconductor design, Environmental effect of fabrication technology.

EEE 6331: Semiconductor Characterization Techniques

3 Credits

Semiconductor material characterization resistivity, mobility, doping, carrier lifetime, device properties, threshold voltage, interface charge of MOS devices, optical and surface characterization of films. Structural characterization: X-ray diffraction (XRD), low energy electron diffraction (LEED), reflection high energy electron diffraction (RHEED), atomic force microscopy (AFM), scanning tunneling microscopy (STM), scanning electron microscopy (SEM), transmission electron microscopy (TEM), Rutherford backscattering spectroscopy (RBS), energy dispersive x-ray analysis (EDX), Auger electron spectroscopy (AES), electron energy loss spectroscopy (EELS), secondary ion mass spectroscopy (SIMS), X-ray photoelectron spectroscopy (XPS), elastic recoil detection (ERD). Electrical characterization: resistivity measurements, Hall measurement, current-voltage (I-V), capacitance-voltage (C-V), deep level transient spectroscopy (DLTS), lifetime measurements. Optical characterization: optical transmittance and reflectance spectroscopy, ellipsometry, photoluminescence (PL), Raman spectroscopy, Fourier transform infrared spectroscopy.

EEE 6341: E & M Properties of Materials

3 Credits

Introduction to electric field, magnetic field and EM waves, wave propagation through isotropic, anisotropic and gyro tropic media. Scattering of EM Waves. Microwave antennas-theory and design. Advanced topics in EM theory.

Electric Properties: Polarization, electrical conductivity and dielectric losses. Pyroelectric phenomena . piezoelectric effect and electrostriction. Domain structure and peculiarities electric properties of ferroelectrics and anti-ferroelectrics. Structure and properties of some ferroelectrics and anti-ferroelectrics. Phase transition in ferroelectrics, fundamentals of spontaneous polarization theory.

Magnetic Properties: Disordered magnetics, ordered magnetics. Domain structure of ferromagnetic crystals and magnetization processes. Anisotropy of ferroelectric crystals. Structure of some magnetically ordered crystals and reorientation transition. Piezomagnetic and magnetoelectri effect.

EEE 6351: Semiconductor Device Modeling and Simulation

3 Credits

Physics and Properties of Semiconductors,equilibrium and non equilibrium process, P-N Junction, Bipolar transistor, State-of-the-Art Bipolar Transistor Technology, Metal-Semiconductor Contacts, Metal-Oxide-Silicon System, MOS Field-EffectTransistor, State-of-the-Art MOS Technology. Signal and small signal model development for semiconductor diodes, BJTs, and MOSFETs. Analysis of charge distribution in PN diode, MOS transistor for different bias voltages, Simplified complex model that represents experimental data, analyze the validity and determine the complexity needed in a computer model of semiconductor Device fo a particular application, Parameter extraction, numerical algorithm, and SPICE simulation for measurement of conductivity as a function of temperature , doping concept.

EEE 6302: Advanced VLSI Technology

3 Credits

Trends and issues in high performance digital VLSI design : In depth study of VLSI architectures and VLSI design methodologies, interconnect as key limiting factor, wire modeling, clock distribution of high speed system, power distribution, crosstalk and power distribution noise. High speed circuit design techniques; Low power design issues; High density and high speed memory design; SOI technology and circuits. VLSI circuits in signal processing, wireless communication, networking and embedded systems etc. VLSI architecture choice ranges from ASIC, full custom approach and special purpose processor to general purpose microprocessors.

EEE 6312: VLSI Devices, Circuits and System Models

3 Credits
Physical defects in VLSI Circuits. Complexity and economics of testing. Fault models: Stuck-at, Stack-on, Stack-open, bridging and delay faults. Testing combinational logic circuits : terminologies , path sesicization, fanout and reconvergence, fault matrix , fault collapsing . test generation using D-algorithm, Boolean difference and other methods. Testing sequential logic circuits : problems and remedies ; Testability of different types of CMOS circuits for various faults . test invalidation . Robustly testable CMOS circuits ;Test generation for static and dynamic CMOS. Design for testability: different techniques of enhancing testability scan design techniques, built-in self (BIST) Built-in current sensors (BICS) for IDDQ testing of CMOS circuits. Error detecting codes and self-checking circuits. Testable design of regular array architectures and PLAS: Testable design of regular array architectures and PLAS: the concept of C-testability.
Detailed study VLSI circuit and system models considering performance, signal integrity, power and thermal effects, reliability and manufacturability. Principles of modeling and optimization co-development.

EEE 6322: Analysis and Design of Digital IC
3 Credits
Principles of IC fabrication process, technical limitation of IC design, bulk and epitaxial growth, advanced process simulation tools. comparison in design of analog and digital IC, Analysis and comparison of modern logic families (CMOS, bipolar, BiCMOS, GaAs). MSI digital circuits (flip flops, registers, counters, PLAs). VLSI memories (ROM, RAM, CCD, bubble memories, EPROM, EEPROM) and VLSI systems. MOS inverter-Resistive load, Depletion load, CMOS inverter, Switching Characteristics of MOS inverter. Static and dynamic CMOS design, CMOS Transmission gates, Power consumption in CMOS gates, Low power CMOS logic ckts.

EEE 6332: CMOS Analog IC Design
3 Credits
Principle and techniques of CMOS IC design for high performance, low power, and RF application. Review of CMOS technology and MOS transistor operation principles. Basic CMOS analog building blocks, including current mirrors, inverting amplifiers, differential pairs, and cascade amplifiers, Frequency response, stability, and frequency compensation are explained, followed by the design of one-stage and two-stage operational amplifiers. This course provides students with some insight into the model-based development of sub circuit specifications, important topics as common-impedance coupling and substrate coupling, pervasive sources of design errors and filtering in both the analog and digital domains. signal processing boundary between the two domains and the modeling requirements of each.

EEE 6342: Radio Frequency Integrated Circuits (RFIC)
3 Credits
HF Distributed parameter circuit theory vs. low frequency lumped parameter circuit theory. Behavior of passive circuit parameters at RF and Microwave frequencies. HF transmission lines, different types of modern RF transmission lines, different types of planar transmission lines, transmission line equations, solutions, Smith Transmission Line Chart and its applications in solving RF transmission line problems, RF impedance matching techniques. LC resonant circuit at low frequencies and at RF frequencies, microwave cavity resonator. Multiport RF network, Impedance matrix, Scattering matrix, transmission matrix representation and their properties. RF filters, different types of RF filters. RF active semiconductor devices for applications in RFIC, RF diodes. BJTs for RF, FETs for RF, HBTs for RF, HEMT, biasing circuits and matching circuits. RF semiconductor amplifiers, broadband amplifiers, high power amplifiers. RF oscillators, FET oscillator, DRO, other RF oscillators. RF Mixers for application in RFIC. Monolithic Microwave Integrate Circuit (MMIC). RF antennas for application with RFICs.

EEE 6303: Nanotechnology & Nano Systems
3 Credits
Physics of semiconductor nanostructures and devices: Theoretical methods for circulating electronics and optical properties of semiconductor structures. Quantum size effects and low

dimensional systems,. Application of semiconductor nano scale devices, including negative resistance diodes, transistors and detectors.
Nano materials and nanostructures: graphene, carbon nano tubes, fullerenes, molecules and organic nanostructures. Synthesis methods of nanostructures: electric arc, pulsed laser deposition, chemical vapor deposition (CVD); thermal CVD, catalytic CVD, micro wave CVD (MWCVD), plasma enhanced CVD (PECVD), spray pyrolysis. Physical and opto-electronic properties; characterization techniques. Applications: carbon nanotube and graphene based devices, bio-sensors, bio-inspired nanostructures, molecular motors, fuel cells and solar cells.

Nano systems and Devices: Introduction- nano materials, nano devices, nanostructures. Nanoscale Lithography: X-ray, Electron-Beam and Ion-Beam; Soft Lithography; Scanning Probe Lithography. Advances in Device Technology: nanoscale silicon devices, process technology, present challenges. Self Assembled Nanocrystals: self assembly, surface defects and passivation, structures, energy levels, transitions, luminescence and lasing. Nano Electro Mechanical Systems (NEMS): stress in thin films, mechanical to electrical transduction, surface engineering techniques, process flow, NEMS actuators, high aspect ratio system technology. Nano Biotechnology: scope and dimensions; detection of biological species on electrical, mechanical and optical criteria; Bio functionality on silicon; Biochip sensors and systems- structures, process technology.

EEE 6313: Quantum Mechanics and Nanostructures
3 Credits
Principles of quantum mechanics for application in lasers, solid state and nano structures, non-linear optics. Effective mass, Schrodinger equation, eigen function expansion, observables, uncertainity principles, matrix representations, green's function, central force problems, Hilbert space, WKB approximations, radiation theory.
Fundamentals of non-equilibrium statistical mechanics, scattering and relaxations. Carrier transport, density of states, current, tunneling and transmission probabilities. Introduction to transport in the collective pocture. Basic principles of few effective devices, resonant tunnel diodes, super lattice quantum wire and dots.

EEE 6323: Thin Film Growth and Deposition
3 Credits
Introduction to Thin Film Technology. Vacuum systems. Kinetic theory of gases. The physics and chemistry of evaporation/deposition mechanism. Physical vapor deposition and related techniques. Theories of epitaxy and nucleation, molecular beam epitaxy. Chemical vapor deposition techniques: reaction types, growth kinetics. Liquid phase epitaxy and related techniques. Theories of plasma and discharges. Sputtering (DC, RF and ECR). Solution based deposition techniques (Sol-gel), spray pyrolysis. Thin film deposition techniques for the fabrication of microelectronic, semiconductor, and optical devices.

EEE 6304: Advanced Optoelectronics
3 Credits
Geometrical optics and Ray-transfer matrix: Reflection, refraction, imaging, and lenses. Definition of ray-transfer matrix and applications. Electromagnetic theory of light: Optical wave functions, wave equations, Maxwell's equations in various media, energy flow and absorption. Interference: Principle of superposition and interference, two-beam interference and interferometry, multi-wave intereference, Fabry-Perot interferometer, group/phase velocity and dispersion. Diffraction: Fraunhofer diffraction, Fresnel diffraction, diffraction at aperture and straight edge, diffraction gratings. Polarization: Jones vectors and Jones matrices, Fresnel equations, polarization devices. Photon, laser, and Gaussian-beam optics: Photon optics, laser basics, optical resonators, Gaussian beam, transmission of Gaussian beams through optical components. Semiconductor optics: Basic semiconductor physics, interaction of photons with semiconductors, absorption and emission. Semiconductor photonic devices: p-n junctions, light-emitting diodes, semiconductor lasers, photodetectors, optical waveguide. Basic three layer planar waveguide, the symmetric waveguide, asymmetric waveguide, anisotropic and gyrotropic rectangular waveguides, channel waveguides, strip loaded Waveguides and coupled mode theory. polarizers, couplers, waveguide fabrication.

Integrated Circuits: Waveguide modulators, detectors, wave-guiding lasers, prism, lens, Introduction to holography, introduction to nonlinear optics, electronics effect and deices, non-linear optical components. Advanced light microscopy, semiconductor optoelectronic devices, organic optoelectronic devices. Magnetoopic effect and devices and Acousto-optic effect and devices, integrated optic memories. Optical A/D, and D/A converters, semiconductor quantum well structures. Quantum wires and dots Hetero structure super-lattice, photon switching and multiplexing. Introduction to holography, Non linear optics and application of nonlinear optics.

EEE 6314: Laser Theory

3 Credits

Generation of photon, wave –particle duality. Direct and Indirect band gap materials. Stimulated and spontaneous emission. Integral parts of a laser. Pumping techniques in lasers, gain medium, different types of optical resonators. Semiconductor Lasers. Modulation of lasers. Stimulated and spontaneous emission, atomic and spectral line width, 3-level atomic, systems. Laser operation under steady state condition, laser output coupling and power. Line width, Linearized dynamic Theory, Q-switching, cavity pumping and mode locking. Optical pumping techniques, frequency tuning and FM harmonic generation and mixing. Line broadening mechanisms: homogeneous and inhomogeneous broadening. Open resonator and Gaussion beam, stability criterion for optical resonators. Field Theory, Ray Theory, Principles of operation of gas, solid state and semiconductor lasers. Phase compression and solition pulse formation. Non-linear pulse generation. Solition laser, additive pulse mode locking, parametric oscillators. Pulse measurement techniques. Microscopic and macroscopic laser phenomena and propagation of optical pulses using classical formalism. Ultrashort laser pulse characteristics.Pulsed laser holography, Micro irradiation application of laser in Medical field for eye, dental treatment etc.

EEE 6324: Solar Cell Technology

3 Credits

Photovoltaic (PV) Competitive technology: monocrystalline Si, Bicrystalline Si, Amorphous Si , background of solar cell, Basic structure of a semiconductor solar cell, materials used for fabrication of solar cells, kronig penny model, pn junction diode, carrier life time, photoemission and absorption, recombination, auger recombination, classification of multi junction solar cell, organic solar cell, plastic solar cell, MIS solar cell, Bifacial solar cell, buried contact solar cell, manufacturing, device configuration, auxilary circuits, fabrication, Si cell process technology- .oxidation, metallization, antireflection, passivation, characterization, Losses of solar cell, solar cell efficiency factors, , solar cell design and analysis, instrumentation and measurement techniques-PCVD, power generation, irradiation, quality control, present trends, applications, future aspects, high effcienty solar cell, LED and solar cell, Single nano wire Si solar cell, Photo electromechanical solar cell, hybrid organic solar cell, PV technology in Bangladesh.

EEE 6334: LCD Technology

3 Credits

Introduction to LCD technology, Basic opto-electronics, Optics review, use of Mueller Matrices, Lorentz Lorentz equation, Light Propagation and Optical material characteristics, polarization of electromagnetic wave, classification of polarization of EM wave, birefringence, Polarized Light and Crystal Optics, Basic Properties of Liquid Crystals fabrication, applications. Materials, terminology, effects, and devices used in the field of liquid crystal optics. Basic structures in nematic and cholesteric liquid crystals, optical phenomena like transmittance, absorption, scattering, birefringence and selective reflection (the effect seen in scarab beetles and utilized to protect the OMEGA laser at LLE from blowing itself up). Surface Alignment Key device applications- LC chemical composition/physical properties and molecular alignment, manufacture and operation of passive devices like wave plates and selective reflection polarizers. Thermodynamics of LCD, Calculus of variation, brachistotrone problem, Euler lagrange equation, Long rod model, Maier saupe theory, dynamic continuum theory, Engineering of liquid crystals- Poincare sphere, mauguin condition, Active matrix, Component integration and fabrication, Image enhancement, Basic electro-optics for active devices - EO switches and LC displays, monitor, tv. Mood rings, polarizing pigments for document security, smart windows, and car paint applications.

EEE 6305: MEMS Device

3 Credits

Introduction to micromachining technologies and micro electromechanical systems (MEMS). Methods of micromachining and how these methods can be used to produce variety of MEMS, including microstructures, micro sensors, and micro actuators. Bulk and surface micro machining, Optical MEMS, instrumentation and applications.

Micro fabrication processes capable of achieving desired MEMS device. Silicon Nitride and Poly-silicon Depositions, Photolithography, Dry and Wet etching processes, Metal depositions and etching and their combination in process integration. Material issues: chemical resistance, corrosion, mechanical properties, residual, intrinsic stress, MEMS design methods, Computer aided MEMS.

EEE 6315: Microwave Solid State Devices and ICs

3 Credits

Physical principles and design considerations of microwave solid state devices, Microwave resonant circuits and different types of Microwave Resonators. Modern microwave transmission lines, planar microwave lines, Microwave Integrated Circuits, Monolithic Microwave Integrated Circuits. schottky barrier mixer diodes, IMPATT diodes, transferred electron devices, tunnel diodes, microwave transistors. Introduction to N port network for lossless Junctions, Scattering parameters of n-ports . Microwave Resonant circuits and different types of resonators. Modern microwave transmission lines, microwave integrated circuits (MICs); Monolithic Mirci wave IC, TEM, quasi TEM and non TEM type MIC lines, NMIC technology and design, conductor and dielectric losses in planar transmission lines, multi-conductor lines, discontinuities. microstrip lines. Microwave passive devices: directional couplers, hybrid junction / magic Tee, Wilkinson power divider, microstrip line filters, isolators, phase shifters, attenuators. Microwave amplifiers and oscillators using FET and GaAs MESFET fabrication devices, High electron mobility transistor, Hetero junction bipolar transistor fabrication and modeling.

6325: Power Semiconductor Devices and Circuits

3 Credits

Fundamental understanding of modern power semiconductor devices and integrated circuits (ICs) in relation to their applications in power electronics systems.

Static switching devices, characteristics of SCR, BJT, MOSFET, IGBT, SIT, GTO, MCT. Classifications of static power converters and their application. Control circuits for static power converters. Pulse width modulation; PWM control of static power converters. Switch mode DC to DC converters, resonant converters, Fourier analysis of static converter waveforms, HD, THD, pf, ZVS and ZCS of static converters. Hysteresis current of AC drives.Input output filter design of static power converters.

Design of SCR communication circuits, base and gate drive circuits of static switching devices, snubber circuits, switching losses and heat sink. Input/output filter design of static power converters. Design of protection circuits for static power converters. Scalar and vector control of AC machines using static power converters. Design of microcomputer controllers for static power converter switching.

EEE 6335: System on a Chip Design

3 Credits

System-level and SoC design methodologies and tools; HW/SW co-design: analysis, partitioning, real-time scheduling, hardware acceleration; Virtual platform models, co-simulation and FPGAs for prototyping of HW/SW systems; Transaction-Level Modeling (TLM), Electronic System-Level (ESL) languages: System C; High-Level Synthesis (HLS): allocation, scheduling, binding, resource sharing, pipelining; Design partition, high-level and hybrid modeling: Bus and cache structures, DRAM interface. SoC parts. SoC and IP integration, verification and test, Design, Exploration. Hardware/software interfaces and co-design. Memory maps. Programmer's model. Firmware development. Transactional modeling. Electronic Systems level (ESL). IP-XACT. Instruciton set simulators, cache modeling and hybrid models.

EEE 6345: Superconducting Device

3 Credits

Physics and electronics of superconductors: Superconducting phenomena and BCS theory. Metal and oxide superconductors. Magnetic properties of superconductors: Meissner effect and magnetic penetrating path. Superconducting devices: DC and Josephson effects, SQUID. Analog applications: EM wave detection, standard voltage generation, weak magnetic field detection. Digital applications: High speed digital circuits. International standards for quantum electrodynamics. Device fabrication and new superconducting materials.

EEE 6355: Biomedical Electronic Devices

3 Credits

Basic components of a biomedical system: Transducers-selection criteria-Piezo electric: ultrasonic transducers–Temperature measurements-Fiber optic temperature sensors. Electrodes-Limb electrodes-floating electrodes-pregelled disposable electrodes-Micro, needle and surface electrodes-Amplifiers: Preamplifiers, differential amplifiers, chopper amplifiers-Isolation amplifier.

ECG-EEG-EMG-ERG-Lead systems and recording methods-Typical waveforms. Electrical safety in medical environment: shock hazards-leakage current-Instruments for checking safety parameters of biomedical equipments

Measurement of blood pressure-Cardiac output-heart rate-Heart sound-Pulmonary function measurements-Spirometer-Photo Plethysmography, Body Plethysmography-Blood Gas analysers: pH of blood-measurement of blood pCO2, pO2, finger-tip oxymeter-ESR, GSR measurements.

Radio graphic and fluoroscopic techniques-Computer tomography-MRI-Ultrasonography-Endoscopy-Thermography - Different types of biotelemetry systems and patient monitoring-Introduction to Biometric systems.

Pacemakers-Defibrillators-Ventilators-Nerve and muscle stimulators-Diathermy-heart-Lung Machine-Audio meters-Dialysers-Lithotripsy.

EEE 6501: Computer Methods in Power System Analysis

3 Credits

General review of network theory, matrix analysis and computer modeling. Incidance matrices, primitive networks and formation of impedance and admittance network matrices. Algorithms for formation of network matrices. Three-phase networks: symmetrical components and sequence impedances, balanced and unbalanced faults. Faults impedance and admittance matrices. Short circuit studies using ZBUS and ZLCOP, open circuit fault studies. Load flow studies, power flow equations. Gauss-Seidel. Newton-Raphson, decoupled and fast decoupled methods of load flow analysis. Three phase load flow.

EEE 6511: Power System Stability

3 Credits

Principles of angular and voltage stability. Methods of multi machine transient stability: direct methods and time domain simulation. Equal area criterion. Extended equal area criterion, transient energy function (TEF) methods. Nonlinear system stability- Lyapunov's method. State space concepts and dynamic system representation. Eigen vectors in dynamic system analysis. Detailed modeling, simplifications, salient synchronous machines and induction machines modeling. Turbine governor, generator excitation systems and their representation in stability models. Power system stabilizers. On line identification and improvement of stability through on line control.

EEE 6521: Power System Control

3 Credits

Overview of requirements and constraints, real time operation and monitoring in power system; supervisory control and data acquisition (SCADA). Energy management system (EMS); on-line application functions; state estimation, short term load forecasting, unit commitment, automatic generation control (AGC), load frequency control (LFC) and security control. Open architecture

EMS, on-line algorithm's speed enhancement: sparsity exploitation, fast decoupling, model/system decomposition, parallel processing-hierarchical computer and array processor configuration, application of expert system, pattern recognition, artificial neural network (ANN), fuzzy logic and genetic algorithms. EMS in the context of deregulation of utilities and independent system operator (ISO).

EEE 6531: Modern Power System Modeling

3 Credits

Overview of power electronic applications at utility and demand sides; sources of harmonics; utility devices and consumer loads. Various models for nonlinear and dynamic loads. High voltage direct current (HVDC) transmission system modeling. AC-DC load flow studies. Modeling of flexible AC transmission systems (FACTS): conventional thyristor controlled reactors and phase shifters, voltage source inverter (VSI) based static condenser (STATCON) and unified power flow controller (UPFC). Transient stability and sub-synchronous resonance (SSR) studies incorporating super conducting magnetic energy storage (SMES) model. Modeling of utility interfaced photovoltaic and wind energy sources. Power quality, cyclic and noncyclic voltage flicker, total harmonic distortion (THD) analysis, remedial measures and harmonic load flow studies.

EEE 6541: Power System Reliability

3 Credits

Review of basic probability theory. Basic reliability concepts. Markovian model of generation unit. Development of load models. Probabilistic simulation of generating systems. Reliability indices. Recursive, segmentation and cummulant method to obtain loss of load probability (LOLP). Modeling of forecast uncertainty. Reliability evaluation of energy limited systems. Different techniques of evaluating reliability, reliability indices of interconnected systems. Composite transmission and generating system reliability.

EEE 6551: Optimization of Power System Operation

3 Credits

General principles of optimization, its application to power system planning, design and operation. Probability analysis of bulk power security and outage data. Economic operation of power system-economic operation of thermal plants, combined thermal and hydro-electric plants. Theory of economic operation of interconnected areas. Development and application of transmission loss formulae for economic operation of power systems. Method of optimum scheduling and dispath of generators.

EEE 6561: Power System Planning

3 Credits

Basic objectives of power system planning. Generation expansion planning process. Electrical demand forecasting; current demand forecasting approaches. Generation planning; economic analysis, expected energy generation, expected fuel cost. Both-Baleriux, cummulant and segmentation methods. Probabilistic simulation of hydro and energy limited units. Expected energy production cost of interconnected systems. Economic aspects of interconnection. Different aspects of load management; effects of load Management on reliability and on production cost. Joint ownership of generation.

EEE 6502 Design of Electrical Machines

3 Credits

Introduction to Design of Electrical Machines. Review of standard design procedures of DC machines, AC machines, Transformers and Special Machines. Optimization of design procedures. Applications of material balance and critical path principles in electrical design. Design economics

and safety factors. Applications of computers in designing DC generators, DC motors, AC generators, AC motors, Transformers and Special Machines. Mechanical design of electrical machines.

EEE 6512: Generalized Machine Theory

3 Credits

Introduction to generalized machine theory. Kron's primitive machine: moving to fixed-axis transformation; Park's transformation: three-phase to d-q transformation: variable co-efficient transformation: other transformations. Matrix and tensor analysis of machines. Three phase synchronous and induction machines: two-phase servo motor: single phase induction motor. Smooth-air gap two-phase synchronous machine. Two-phase induction machine. The n-m winding symmetrical machine. Diagonalization by charge of variable. Symmetrical three-phase machine and special limiting cases.

EEE 6503: Renewable Energy Resources and Technologies

3 Credits

Renewable Energy Resources and Technologies: Definition and types of Renewable Energies. Resource availability, technologies and applications: Solar Energy: thermal and photovoltaics system design, planning and implementation. Wind Energy: resources, turbines and applications, system design, planning and implementation. Hydropower: resources, turbines, small hydro power systems and applications, system design, planning and implementation. Biomass Energy: resources, thermal and non thermal applications of biomass and biofuels, system design, planning and implementation. Geothermal Energy: resources, heat and electricity applications, system design, planning and implementation. Other Renewable Energy Resources: Tidal, Wave and Ocean thermal Energy Conversion, system design, planning and implementation.

EEE 6513: Environmental Impact of Generation of Electrical Energy

3 Credits

Role of electricity from fossil fuels, nuclear fuels and renewable resources. Impact of high voltage transmission lines, Pollution from thermal power plants. Health effects of electricity generation. Study of Environmental Impact Assessment (EIA), Assessment of cogeneration cycles and demand side management. Emission control in the Generation of Electric Power in Bangladesh, Energy Efficiency, and Energy efficient Technologies. Concepts of Clean Development Mechanism (CDM) projects, CDM projects in Bangladesh.

EEE 6504: Industrial Electrical Distribution System Planning

3 Credits

Distribution system planning: Electrical power transmission and distribution, statutory requirements, voltage standards, load estimates, Half hourly demand statistics, plant ratings, security standards, consumer interruption, Fault levels, Reinforcement, Special fault level control, Flicker voltage; Industrial system planning: power factor control, synchronous motor performance, System planning: Power factor control, synchronous motor performance, synchronous generator performance, Induction motor performance, Behavior of Electric motors during starting, performance of interconnected machines, Motor recovery after faults, Rectifier loads, voltage compensation methods, Industrial cogeneration , Special problems of industrial cogeneration.

EEE 6514: Smart Grid Design and Application

3 Credits

Introduction to smart grid technologies. Operating principles and models of smart grid components, including distributed energy sources and distribution feeder components. Communication infrastructure for smart grid operation. Advanced metering infrastructure and advanced control

methods. Demand response and demand management. Distribution feeder analysis. Impact of smart grid component integration on distribution network operation. Smart grid reliability evaluation.

EEE 6505: Modern Power System Protection

3 Credits

Review of characteristics of over current, directional, differential, distance and pilot relays; Principles of relay design; Effects of transients on relay operation; Sensitivity and Stability of differential relays; Harmonic relaying; Static and digital relays; Digital relay Algorithms; Applications of static and digital relaying in various protection schemes of Generators , Power Transformers, Large otor, Buusbar and Transmission line.

EEE 6701: Advanced Telecommunication Engineering

3Credits

Challenges in modern communications technology, baseband and broadband signal transmission, first and second Nyquist's criteria for zero intersymbol interference; robust signal compression and detection techniques, optimum receivers, design of frequency- and time-domain equalizers and echo cancellers; wired and wireless channel characteristics, AWGN channels, time-varying multipath faded channels, channel modeling; advanced source and channel coding techniques, high bit rate digital modulation schemes and MODEMs; SS7 and HDLC protocols, H.323, H.26x, RTP and SCTP; modern high speed communication networks and emerging technologies, access and backbone networks, intelligent networks, NGN; advanced switching and routing principles, complex multiplexing and multiple access techniques, orthogonal signals, OFDM, DWDM; broadband wireless communication, spread spectrum techniques, CDMA2000 and WCDMA, multi-carrier systems; 3G and 3GPP mobile communications and WiMAX technology, UMTS, VoIP, IP TV, HDTV, LTE.

EEE 6711: Telecommunication Switching and Queue Systems

3Credits

Resource sharing and need for switching; Need for networks; Store and forward switching; Packet switching; Circuit switching; Traffic considerations. Erlang. Types of telephone switching systems; Signaling; Two/four wire transmission; Telephone set; Telephone network organization; Principles andexamples of step by step, cross bar and reed relay systems; Electronic switching and stored program control systems; Digital switching-time, space and hybrid switches; Examples of digital exchanges.

Queue modeling and analysis with applications to space-time digital switching systems and to integrated-service telecommunication network. Fundamentals of traffic engineering with queuing theory, queue size, waiting time, busy period, blocking and stochastic process analysis for Markovian and non-Markovian models.

EEE 6721: Advanced Communication Network and Protocol

3 Credits

Introduction and OSI Layering System Transmission - media, signals, asynchronous and synchronous, compression, huffmann; Physical Layer Data link Layer - go back n and selective repeat; LANs - ethernet, token ring, polling Network Layer - routing and flow control; Transport and Higher Layers - TCP/IP Circuit Switching - Telephone network; Erlangs Equations - queueing theory; Integrated Services Digital Network, ISDN B-ISDN and ATM, standards, traffic Future Trends and Conclusions.

SONET Transport Networks: Rationale for High Speed Networking - Evolution of Optical Networks - SONET Technology - SONET Transport Network Architectures - Survivability in SONET Systems- Automatic Protection Switching (APS) - Restoration Techniques - Self Healing Rings - IP-over - SONET. ATM Transport Networks: ATM Technology - Protocol Reference Model - Network Traffic Management - Protection and Restoration Techniques - IP-over- ATM-over-SONET. WDM Networks and Wavelength Routing: Wavelength Division Multiplexing (WDM) Technology - Wavelength

Cross-Connects -Wavelength Routing Networks, WDM R(i), and wavelength convertible Network-Routing and Wavelength Assignment - Distributed Control Protocols - Wavelength Rerouting. Routing Algorithms - Converter Placement . WDM Optical Layer Design: Terabit Transport Networks - Layered Architecture - Design of Optical Layer - Virtual Topology -Problem Formulation-Design Heuristics- Multi-Fiber Networks. WDM Network Survivability and Optical Packet Switching: Network Survivability - Protection and Restoration Techniques - Optical Layer with Fault-tolerance Capability - Optical Packet Switching - IP-over-WDM. Advances in WDM technologies: Introduction to DWDM (Dense Wavelength Division Multiplexing) technology and its features, Next generation optical networks and intelligent network.

EEE 6741: Communication Network Planning, Security and Modelling

3 Credits

Purposes and procedures of network planning: wired and wireless, Site survey and selection; wireless network Propagation analysis and coverage planning; Capacity planning; Radio frequency planning; Advanced planning aspects. Cell Planning: Traffic and coverage analysis, Nominal cell plan, surveys, System design, System implementation and tuning, System Growth, Re-use of frequencies in a cell, Hierarchical Cell Structure (HCS), Multi-band Cells. Telecommunication Subscriber Services, Mobile Intelligent Network, CVPN, CAMEL, Charging and Billing, Operations & Maintenance Systems, System architecture & Industrial implementation.

Overview of security, threats and mechanisms; Conventional encryption algorithms (DES, IDEA); Public Key cryptography, RSA, Key management, confidentiality authentication and digital signatures; Network-based threats: Intruders, Viruses and Worms; Hardware architectures required to implement algorithms; Firewalls.

Time and Frequency Domain Modeling of signals, Techniques for Physical Layer Simulation, Performance Measurement in simulation, Physical Layer Simulation examples (Optical Communications, Radio Communications, Electrical Communications), The Theory of Network Simulation, Network Simulation Examples.

EEE 6702: Advanced Optical Fibre Communication

3 Credits

Basics of Optical Communication- Optical fibre; Optical sources; Optical amplifiers; Optical modulation and detection schemes. Direct and coherent detection receivers: configuration, operation, noise sources, sensitivity calculation, performance curves. Design of analog and digital receivers. Transmission link analysis: point-to point and point-to multi-point links, system configuration, link power budget, rise time budget, line coding schemes, transmission system limitations, design of fibre-optic systems. Optical data buses, optical networks, fibre distributed data interface (FDDI) and synchronous optical network (SONET). Orthogonal frequency division multiplexing (OFDM) and wavelength division multiplexing (WDM) transmission systems. Optical networking: principles and challenges; evolution of optical networks, wavelength routed network, wavelength division multiplexing (WDM) network, sub-carrier multiplexing optical networks. Enabling technologies: optical transmitter, optical fiber, optical receivers, optical amplifiers, optical switching elements, optical cross-connects (OXC), multiplexers/demultiplexers, wavelength routers, optical wavelength converters, WDM network test beds. Network architecture, IP over WDM.

EEE 6712: Optical Networks

3 Credits

Fundamentals of optical Networking; Difference between networking and transmission Bandwidth management, topology, OSI reference model, internet growth, Evolution, WDM Network, Enabling Technologies, Network Architecture; Broadcast optical networks: single and multiple hop networks, channel sharing and multi-casting, shared channel multicasting network-GEMNET, performance evaluation for unicast and multicast traffic, experimental WDM networks. Wavelength routed networks: virtual topology design, routing and wavelength assignment, circuit switched and packet switched approaches, performance evaluation. Reconfiguration in WDM network, network control and management, network optimization, design considerations. Multi wavelength star and ring networks. Photonic switching: Basic 2x2 switch, layered switch designs, blocking, crosstalk, dilation. Optical cross connects. Add Drop Multiplexers, Protocols: PDH, SDH. Shared access networks.

Static and dynamic allocation. Ethernet, optical Ethernet, optical TDM (OTDM) and optical CDMA (O-CDMA) networks, next generation optical networks.All-optical networking: Nonlinear optics. Nonlinear interferometer based optical switches, novel architectures, packet switching, configurable optical switches. Ultrafast packet processing. WDM in the BT network, optical networking, the Marconi perspective, optical networking, the Nortel perspective. Network and Traffic Modeling: Traffic modeling and simulation, self-similar and heavy-tailed
models, Network of Queues.

EEE 6703: Advanced Microwave and RF Engineering

3Credits

Review of basic electromagnetic, Transmission Lines, Wave guides Microstrip Lines, Microwave networks and impedance Matching, Smith chart, Circuit theory for wave guide systems. N port circuits: impedance matrix, admittance matrix, scattering matrix and transmission matrix, their properties, transformers, periodic structures and filters: wave analysis, impedance matching, wave and group velocities; comb lines and their analysis: introduction to microwave filters, filter design by image parameter and insertion-loss methods; design of different type of filters, Active RF Components, Microwave Amplifier Design, Microwave Integrated Circuit(MIC), RF Micro electromechanical System(MEMS) Components, RF Components for wireless System, RF Components for ultra wideband (UWB) Systems.

EEE 6713: Antennas and Propagation

3Credits

Definitions, antenna as antenna as an aperture : arrays of point sources : review of dipoles, loop and thin linear antennas . Helical antenna, biconical and spheroidal antennas . internal-equation methods, current distribution : Self and mutual impedances , antennas patterns, optimum design for rectangular and circular aperture arrays : design and synthesis .Phased array, Discrete arrays, mutual coupling, design of feeding networks, Reflector type antennas: single, multi reflector antenna configuration, array fed reflector antennas , synthesis, pattern analysis and measurement. Banbiner`s principle and complementary antennas . Application of reaction concept and vocational principles in antennas and propagation . Frequency independent antennas . Microstrip antennas Scattering and diffraction . Selected topics in microwave antennas . Antenna measurements: near field and far field measurement techniques. Numerical method of antenna analysis. Application of broadcasting ,microwave links, satellite communication and radio astronomy. Smart antenna: Statistical signal processing concepts, Basics of mobile wireless communications. Radio-frequency signal modeling and channel characterization. Smart antennas and generalized array signal processing. Source localization problem. Joint angle and delay estimation. Smart antenna array configurations. Mobile communication systems with smart antennas.

EEE 6723: Numerical Methods in EM Field Computation

3 Credits

Foundations of function theory, Computational techniques for partial differential and integral equations: finite-difference, finite-element, method of moments. Green’s function, mode matching, numerical experimental techniques in time and frequency domain. Applications include transmission lines, resonators, integrated circuits, solid-state device modeling, electromagnetic scattering, and antennas. Maxwell's electromagnetic field theory and its applications to engineering problems. Fundamental concepts associated with elementary plane wave theory and boundary value problems with applications to half-space reflection problems; fundamental theorems. Analytical techniques (Green's theory, modal analysis, integral equations, etc.) applied to setting up, approximating, and solving radiation, unguided, and guided wave propagation, and scattering by medium discontinuities in open and closed geometries. Reflectors and aperture antennas: aperture theory, analytical and computer-based designs, reflector antenna fundamentals, numerical methods for reflector analysis, general formulation of GO, PO, GTD, PTD and UTD methods, Gaussian beams, reflector optic configurations, prime-symmetric, Gregorian, Cassegrain and prime-offset reflector systems, analysis of strut scattering, aperture blockage, spillover, G/T analysis, measuring and commissioning reflector systems, reflector feed array, focal plane arrays,

Generalized approach to field theory: introduction to reaction concept, wave propagation through isotropic, anisotropic and gyrotropic media. Scattering of EM Waves. Microwave antennas-theory and design. Advanced topics in EM theory.

EEE 6743: EMI and Noise Reduction Techniques

3 Credits

RF and MW components in wireless systems, antenna, passive component, active circuit noise, noise measuring techniques. Theory and practice of E.M. noise coupling, Cross talk, Intrinsic noise sources, Active devices nosie, Digital circuit radiation. Techniques for noise reduction: shielding-near field and far field, shilding equations, shilding with magnetic materials, grounding of shields, contact protection and filtering, interference, type of interferometric. Measurement of EMI to comply with government regulation. EMI problems and solutions to switching power supply applications. Design of EMI filter. EMC software tools for PCB design, Emission control in motherboard, radiated field from SMPS, reducing radiated EMI via internal cabling and packaging, controlling radiation from external cables, radiated emission specifications. Software based studies.

EEE 6704 Advanced Wireless Communications

3 Credits

Overview of broadband wireless communications, multiple access techniques - TDMA, FDMA. Spread spectrum communications - direct sequence spread spectrum (DSSS), FHSS, THSS, modulator and demodulator structure, probability of error, jamming margin, decoding, performance in the presence of interference, PN sequence, CDMA, MC-CDMA, UWB transmission. Multi-user detection: multiple access interference, detector performance measure - BER, asymptotic efficiency, near-far resistance; detectors - matched filter detector, de-correlator detector, MMSE detector, SIC, PIC, MAP and MLSE detectors. Propagation in mobile radio channels; channel models, fading - large scale and small scale fading, flat fading and frequency selective fading channel, fast fading and slow fading channel; delay spread, Doppler spread and angle spread; channel autocorrelation functions, scattering function, correlated and uncorrelated scattering (US), WSS and WSSUS model. Multiple antenna systems, capacity of SISO, SIMO, MISO and MIMO systems, ergodic capacity, outage capacity, STBC, OSTBC, QOSTBC, spatial multiplexing (SM) scheme, SM detection techniques, diversity and diversity combining techniques. Multi-carrier communications; Orthogonal FDM (OFDM), OFDM transceivers. Special issues of OFDM - cyclic prefix, timing offset, frequency offset, synchronization, peak power problem, Broadband wireless Standards.

EEE 6714 Application of CDMA to Cellular Communications

3Credits

Spread spectrum concept. Basics of CDMA. Properties and generation of PN sequences. Basics of Cellular and Mobile communications. Applications of CDMA to cellular communication systems, Walsh and hash functions. Frequency hopping CDMA, synchronized resistance to jamming, spreading and their generation, Transmitter models, Rake receiver model, BER performance analysis in the presence of channel impairments. Second and third generation CDMA systems/standards. Multicarrier CDMA. Synchronization and demodulation issues. Diversity techniques in Rake receiver. Cell coverage and capacity issues. Convolution and turbo codes. CDMA optimization issues.

EEE 6724: Digital Satellite Communication

3 Credits

Introduction: Elements, frequency bands, transmission, multiplexing, modulation, multiple access, Satellite Access, FDMA, TDMA, Introduction to Satellite transmission networks, classification and types of satellites, Historical background, Space environment, Link analysis, communication satellite orbits, orbit period and velocity effect of inclination antenna lock angle, slant range,round trip delay, geostationary orbit, Clark orbit; Earth stations: Earth station antenna, HPA, LNA, Up and

Down monitoring, control and reliability, Satellite services. Modern satellite and ground antenna applications, Satellite phone communication network, Satellite radio, TV, GPS based satellite communication. Satellite system link analysis: Basic link equation, link budget, interference analysis, rain induced attenuation, path diversity, Detailed analysis of multiple access: FDMA, FDA-FM, FM-FDMA, TDMA, burst structure, Super scheme structure, Frequency acquisition condition.

EEE 6734: Remote Sensing

3 Credits

Fundamental of techniques Remote sensing, Historical Background, Satellite base remote sensing techniques, Typical components of Remote sensing, Classification and function of Remote sensing, active remote sensing, passive remote sensing, RF data process and effect of interruption, Data acquisition techniques, data processing, microwave and infrared sensing technique, ocean, ice and atmosphere geographical measurement, Fund of satellite Remote sensing, Radiation and Reflection, Rader equation, measurement system, image data analysis, classification and application access, S/W based RS study.

EEE 6705: Information and Coding Theory

3 Credits

Definition and measure of information, information capacity, channel capacity, Shannon's theorems, Fano's inequality. Fundamentals of error control coding: forward error correction (FEC) and automatic repeat request. . Binary coding: and automatic repeat request. Binary Coding: properties of codes, construction of binary compact codes. Convolutional coding: Viterbi and sequential decoding; algebra of linear block codes, cyclic codes, Hamming, Singleton, Gilbert-Varshamov, and Plotkin Bounds; error correction and detection using block codes; transmission line codes.

EEE 6715: Stochastic Process and Modeling

3 Credits

Introduction to stochastic processes as applied to study of telecommunication systems and traffic engineering. Renewal theory; discrete-time Markov chains; continuous-time Markov jump processes. Engineering applications of probability theory, random variables and random processes. Time and frequency response of linear systems to random inputs using both classical transform and modern state space techniques. Time averages and egodic principle. Simulation of random processes. Applications to traffic and queueing analysis of basic telecommunication system models.

EEE 6725 Theory and Design of Digital filters

3 Credits

Approximation of filter specifications. Use of design charts. Structure of recursive digital filters. FIR, IIR filter design techniques. Limit cycles, overflow oscillations. Wave digital filters. Adaptive filtering: Review of the LMS and RLS algorithms, adaptive lattice-ladder filters, frequency-domain adaptive filtering methods, variable step-size adaptive filters, application of adaptive filtering, Power spectrum estimation: Review of parametric techniques for power spectrum estimation, high resolution methods, Multirate signal processing: filter banks: cosine modulated filter banks, paraunitary QMF banks, multidimensional filter banks, emerging applications of multirate signal processing. Optimal filtering and estimation, Wiener filters, linear prediction. Steepest descent and stochastic gradient algorithms. Frequency-domain adaptive filters. Method of least squares, recursive least squares, fast fixed-order and order-recursive (lattice) filters. Misadjustment, convergence, and tracking analyses, stability issues, finite precision effects. Connections with Kalman filtering. Nonlinear adaptive filters.
Kalman filtering: Kalman signal generation model, statistical estimation theory, maximum likelihood principle, optimum mean square estimation, conditional expectation, Wiener/ Hopg equation, Gram/Schmidt orthogonalization, Kalman filter basics, smoother algorithm.

EEE 6735: Biomedical Signal Processing

3 Credits

Dynamic medical signals: electrocardiogram, electroencephalogram, electromyogram. Detailed analyses of electromedical signals: waveform, origin, interpretation and significance. Linear and nonlinear parametric modeling: autoregressive (AR), moving average (MA), autoregressive moving average (ARMA), bilinear models. Nonlinear nonparametric modeling: neural network, fractal and chaos based models. Software based medical signal detection and pattern recognition. Medical image analysis and compression. On-line monitoring and diagnosis.Mathematical principles of medical imaging modalities, position emission tomography, magnetic resonance imaging, image reconstruction algorithm, system configuration and their effect on reconstruction algorithm.

EEE 6745 Digital Speech and Image Signal Processing

3 Credits

Speech processing: Advanced techniques, with focus on speech recognition by humans and machine. Homographic filters, speech synthesis, Physiology and psychoacoustics of human perception. Dynamic Time Warping (DTW) and Hidden Markov Models (HMM) for automatic speech recognition systems, pattern classification, and search algorithms. Aids for hearing impaired feature extraction, hidden Markov models, noise robustness, measures of similarity, language and accent identification.

Image processing: Fundamentals, image formation, representation in pixel and transform domains, reconstruction from projections and interpolation, human visual system, stochastic models for images, enhancement and restoration techniques in spatial and frequency domains, image processing in color space, morphological filters, multi-resolution image processing, image compression techniques and standards, segmentation for edge detection and texture analysis, pattern classification, image watermarking, registration and fusion, emerging applications of image. processing.

EEE 6755 Digital Video Processing

3 Credits

Video processing: Formation and representation of video, spatio-temporal video sampling, motion analysis and estimation: real versus apparent motion, optical flow, block- and mesh-based methods for motion estimation and region-based stochastic motion modeling, motion segmentation and layered video representations, video filtering: motion-compensated filtering, noise reduction, signal recovery, deblurring, superresolution, mosaicing, deinterlacing and frame-rate conversion, video compression techniques and standards, content-based video indexing and retrieval, video communication: digital television, streaming over IP and wireless networks, error control and watermarking, stereo and multiview sequence processing.
Digital speech communication, Digital TV communication; Characteristics of speech signals; Characteristics of picture signals; Subjective and objective testing; Bit rates in speech and picture communication CCITT recommendations for speech digitization; HDTV, Low resolution TV and Videoconferencing requirements; Time domain waveform coding of speech-PCM, DPCM,ADPCM, DM and subband coding; Frequency domain waveform coding of speech-LTC, ATC; Parameter coding of speech-channel, format and LPC vocoders; Coding of monochrome and colour video signals- Transform and Adaptive transform coding; Subband coding; Vectorquantization; Interframe and Hybridcoding; Delayed decision and run length coding; Effects of transmission errors; Audio and Videoconferencing; Video telephone.

EEE 6706: Communication Measurement Techniques

3 Credits

Basic microwave transmission line theory, Smith charts, Scattering Matrix, S-parameters, simple impedance matching circuits, wave guides, resonators, microwave components, materials, semiconductors, microwave power measurements, reflection co-effect and VSWR measurement, transmission measurements, impedance measurements, frequency measurements, network analyzers, noise measurements, Measurement using scalar network change, Vector network change, microwave power measurement, mobile power measurement.

Basic optical communication, optical source, optical detectors, optical components, length measurement techniques, alignment and angle measurement techniques, interferometer, optical

sensors, miscellaneous techniques. Principles and limitations of current fiber optic testing equipment, testing to SONET/SDH international standards, testing of erbium doped fiber amplifiers, characterization of WDM fiber systems, fiber testing in the local loop, using optical power meters and optical time domain reflectometers. Measurements in the latest state-of-the-art 10 Gb/s systems.
Digital communication layered structure, physical layer testing, measurement and troubleshooting, compact models for measurements Techniques in high speed interconnects, signal processing measurements.
FDTD method, parallel computing, electromagnetic simulation, FDTD simulation of antenna, grid measurements, GSM, GPRS, WiMax, LTE, GPS measurements.

EEE 6901: Engineering Analysis

3 Credits

Engineering problems related to linear/non-linear physical static/dynamic systems: Problem description related to power, communication and electronics branch, Small scale and large scale system representation.

Application of techniques of linear algebra and other branches of mathematics to solve engineering problems

Vector spaces, Cauchy/Schwartz inequality, Gram/Schmidtt orthogonalization, Matix as linear transformations, eigen values and spectrums, Cholesky decomposition, Hilbert, Banach and separable spaces, Resolvent distributions and Green's function, Mellin and Hankel transformation, Wavelet transform.

Important theorems of mathematics for engineering analysis

Chaos and bifurcation theorems Cayley/ Hamilton theorem, Bezout therem, Riesz representation theory, Spectral theory, generation theorem, Hillsen equation, Walsh function, Green's theorem, Kummer's equation, Witlaker's equation, Hypergeometic differential equation, Reimen equation, Lagverve equation, Riccar's equation.

Approximate methods of applied math for engineering analysis

Finite element techniques. Montel carlo method, Rayleigh method for calculating natural frequencies, Galer Kin's method, Kryloft and Bogolioboff method, topological method, Autonomous system, Phase trajectory of Vander Pol equation, Runge Kutta method, FDTD method, Staistical method, Optimization techniques, decomposing large scale optimization problems, cutting plane methods, decomposition algorithm, combination of Optimization techniques.
Example problems related to solution of Laplace's equation, Poisson's equation, Diffusion equation, Van der Pol's equation, Mathien-Hill, Meissener's equation.

EEE 6911: Nuclear Energy

3 Credits

Fundamental on nuclear energy and nuclear power system, ranging from the fundamental principles of nuclear physics, nuclear power system design and operation, waste disposal, to risk assessment and safety management. In addition to technical knowledge, nuclear governance and policy governing the safe and effective operation of nuclear power plant will be covered.

EEE 6902: Nonlinear System Analysis

3 Credits

State and assess conditions for local and global existence and uniqueness of solutions of a non-linear time varying state equation.

Non linear Phenomenon: multiple equation, limit cycle, complex Dynamics, Bifurcations.

Second order NL system: Phase plane techniques, limit cycle, Poincare-Bendixson theory, Index theory.

Input output analysis and stability: Small gain theorem, Passivity, Describing function.

Lyapunov stability theory: Basic stability and instability theory, La Salle's theorem, indirect method of Lyapunov

Linorizatia by state feedback: Input output and full state Linorization, zero Dynamics, Inversion, Tracking, stabilization.

Sliding mode control, back stepping, advanced techniques.

EEE 6912: Nonlinear Control Systems

3 Credits

General introduction: the phase plane: method of isoclines: Linenard's method: Pelts method: common nonlinearities: transient response from phase trajectory: describing function and their applications. Relay servo mechanism. Lyapunov's method. Local Decompositions of control systems, Global Decompositions of control systems, Input –Output Maps and Realization Theory, Elementary theory of nonlinear feedback for Singe-Input Single-Output systems. Elementary theory of nonlinear feedback for Multiple-Input Multiple-Output systems, Geometric theory of State Feedback Tools, Geometric theory of Nonlinear Systems application, Tracking and Regulation, Global Feedback Design for Singe-Input Single-Output systems.

EEE 6913: Modern Control Theory

3 Credits

State space description of dynamic systems: relationship between state equations and transfer function: continuous and discrete time linear system analysis and design using state transition method. Controllability and observability. State feedback and output feedback. Pole assignment using state feedback and output feedback. H control. Optimal control-dynamic programming. Pontryagin's minimum principle. Separation theorem. Stochastic control. Adaptive control.

EEE 6904: Artificial Intelligence System

3 Credits

Knowledge and intelligence, prediction logic and automated reasoning, heuristic general knowledge representation, introduction to the learning knowledge based system, Artificial neural networks: Historical backgrounds, Various structure of artificial neural networks, Hebbian associator. Perceptions : learning rule, illustration proof, failing Adaptive linear (ADALINE) and Multiple Adaptive linear (MADALINE) networks . Multilayer perceptions: generating internal representation Back propagation, cascade correlation and counter propagation networks. Higher order and bidirectional associated memory .Hopfield networks: Lyapunov energy function. attraction basin. Probabilistic updates: simulated annealing, Boltzman machine. Adaptive Resonance Theory (ART) network ART1, ART2, Fuzzy ART mapping (ARTMAP) networks. Kohonen's feature map, learning vector Quantization (LVQ) networks. Applications of neural nets. Introduction to Fuzzy logic based AI system: Mathematical background, various structures, algorithms, application, of fuzzy logic to solve problem. . Introduction to Genetic Algorithm based AI system: Mathematical background, various structures, algorithms, application, of genetic algorithm to solve problem. Combination of ANN, FL, Chaos, evaluation, distributed AI for large scale system.AI based system design, construction and implementation, soft computing.

EEE 6914: Embedded System

3 Credits

Introduction, Methodologies and technologies for design of embedded systems, hardware and software platforms for embedded systems, techniques for modeling and specification of system behavior, software organization, special purpose processors; input-output design and I/O communication protocols; design space exploration for constraint satisfaction; co-design approach; example system design; Formal approach to specification; specification languages; specification refinement and design; design validation; Real Time operating system issues with respect to embedded system applications; time constraints and performance analysis., real-time operating system scheduling, real-time communication and packet scheduling, low-power battery and energy-aware system design, timing synchronization, fault tolerance and debugging, and techniques for

hardware and software architecture optimization. Microcontroller systems, program data request, memory and device interface. Theoretical foundations as well as practical design methods.

EEE 6905: Advanced Biomedical measurement

3 Credits

Oximeters: Oximetry, Ear Oximeter, Pulse Oximeter, Skin Reflectance Oximeters, Intravascular Oximeter, .**Blood Flow meters:** Electromagnetic Blood flow meters, Types of electromagneticBlood Flow meters, Ultrasonic Blood Flow meters, NMR Blood Flow meter and Laser,Doppler Blood Flow meter, **Cardiac Output Measurement:** Indicator dilution Method, Dye dilution Method, Thermal dilution Techniques, Measurement of Continuous Cardiac Output Derived from the Aortic Pressure Waveform, Impedance Technique, Ultrasound method, **Pulmonary function Analyzer:** Pulmonary function Measurement, Spirometery, Pneumo tachometers, Measurement of volume, Pulmonary function Analyzer, Respiratory Gas Analyzers, **Blood Cell Counters:** Types of Blood cells, Methods of Cell Counting, Coulter Counters, Automatic Recognition and Differential Counting of Cells.

Clinical Laboratory Instruments: Medical Diagnosis with chemical tests, Spectrophotometer, Spectrophotometer Type instruments, Colorimeters, Spectrophotometers, Automated Biochemical Analysis Systems, Clinical Flame photometers, Selective ion Electrodes Based Electrolytes Analyzer.

Audiometers and Hearing Aids: Mechanism of Hearing, Measurement of sound, Basic Audiometer, Pure Tone Audiometer, Speech Audiometer, Audiometer System Bekesy, Evoked Response , Audiometery System, Calibration of Audiometers, Hearing Aids.

Patient Safety: Electric Shock Hazards, Leakage Currents, and Safety Codes for Electro Medical Equipments, Electrical Safety Analyzer, and Testing of Biomedical Equipment.

EEE 6706: Robotic System and Control

3 Credits

Introduction to Robotic System

Elements of the system, classifications, History of Robotics, transformations, notation, vector, planes, translations, rotation, inverse application of robotic system.

Analyze robot manipulators and Kinematics:

Kinetics and control, link design, link connection, link frame equation, Denavit-Hartenberg parameters, forward kinematics, manipulator space, joint space, Cartesian space, Inverse kinematics: solvability, manipulator subspace, algebra vs. geometry, static force, Dynamics: Dynamics of rigid bodies, velocity, acceleration, mass, lagrange equation, Newton-Euler, iterative vs. closed form, structure of dynamics equation. Control: Manipulator sensor, Actuator and control system: position, tactile, sonar, force sensors, Actuators: DC motors, stepper motors, pneumotion system, hydraulic system, control systems: position control, force control, robot assembly task, force sensors, constraints, advanced position/force control, Trajectory generation: General, space joint, Cartesian, path generation, robot language, dynamic path equation.

Model robot manipulators and kinematics: Matlab based simulation study, selection criteria of appropriate robotic system for a given application: Features, advantages, limitations, programming and control of industrial robotic system.

Sensor (Tactile, Range Finders, GPS, IMU, Position Encoders), Mapping: Metric Maps, Topological Maps, hybrid, Sensor (Vision), Visibility Graphs, Bug Algorithm, Potential Fields, Generalized Voronoi Graphs, Atlas, Actuators. Locomotion. Manipulators, Subsumption (reactive) architecture, Control Theory, Plant and Sensor Model, the various elements that make an industrial robot system; various applications of industrial robot systems, Analyze robot manipulators in terms of their

kinematics, kinetics, and control, Model robot manipulators and analyze their performance e, through running simulations using software.

EEE 6907: Electronic and Communication devices for Space Engineering
3 Credits
Introduction to space environment from sun to earth's upper atmosphere, fundamental concepts of space plasma physics, examples of observations and data inside dynamic environment, Impact of environment of (space weather) on modern technologies such as solid state devices, satellite technology, communication , global navigation system., robotics, image and digital data processing, control system.

Memorandum of Understanding Between

Ahsanullah University of Science and Technology &

The University of Wyoming

Considering that the one of the principal duties of modern institutions of higher education is to enable students to acquire an international experience, and that this experience is a valuable element in the preparation of their professional life;

Considering that an exchange of faculty between two institutions would be fruitful for the persons participating in the exchange, their research and their teaching;

Considering that institutions of higher education should have documentation and regular information on scientific progress, economic realities and technological advances in the countries chosen as privileged partners;

The following between Ahsanullah University of Science and Technology and The University of Wyoming is agreed upon:

Within the limitation of available funds, a program of mutual cooperation between the two institutions will be initiated which may include any or all of the following:

An exchange of students with a special emphasis on Ahsanullah University of Science and Technology upper division students being permitted to enroll in appropriate University of Wyoming degree programs,
An exchange of faculty,
An exchange of documentary resources,
Cooperation in potential joint technical assistance activities,
Cooperation in research projects and or programs, and
Sponsorship of international workshops and or symposia.

Specific activities will be documented in addenda to this memorandum or in specific cooperative agreements.

Yunus Bagby
For the University of Wyoming
11 DEC., 1996

Mustafiz Hussain Khan
For Ahsanullah University of Science and Technology
1/1/1996, 1996

Memorandum of Cooperation

Drexel University
Philadelphia, PA, U.S.A.
and
Ahsanullah University of Science and Technology
Dhaka, Bangladesh
June, 1998

Whereas Drexel University and Ahsanullah University of Science and Technology share a common ethic, interest, motivation and commitment to excellence in education, research and technology development, and

Whereas Drexel University and Ahsanullah University of Science and Technology will continue to meet, to discuss program planning in view of their shared interests, priorities and objectives, and

Whereas Drexel University and Ahsanullah University of Science and Technology are committed to a shared vision that builds on the expertise of their respective institutions for the benefit of both institutions and society at large.

Be it therefore resolved that Drexel University and Ahsanullah University of Science and Technology admit and acknowledge a mutual commitment to work toward joint programs, shared activities and mutually beneficial efforts including student transfer, staff exchange and research programs, and

Be it further resolved that as Drexel University and Ahsanullah University of Science and Technology work together toward shared goals and understandings, they commit to a relationship, while not exclusive, that is exceptional in purpose and effort.

Drexel University

Papadakis

Constantine Papadakis
President

Ahsanullah University of Science and Technology

M. Ishaq Hussain Khan

M.H. Khan
Vice-Chancellor

MEMORANDUM OF AGREEMENT (MOA)

Between

Washington State University
Pullman, WA, USA

And

Ahsanullah University of Science and Technology
Dhaka, Bangladesh

Article I. Parties and Purpose

Ahsanullah University of Science and Technology (AUST) and Washington State University (WSU) conduct programs and activities of basic and applied research, education and training, technology and information transfer, and economic development. The AUST and WSU have capabilities and expertise and conduct programs and activities of interest and potential benefit to the other. The AUST and WSU agree to establish and conduct mutually agreed upon cooperative and collaborative projects, programs, and/or activities, which will enhance the programs of each.

Article II. Areas of Cooperation and Collaboration

The AUST and WSU agree to establish and conduct projects, programs and/or activities in one or more of the following general areas. Specific details of each will be defined by mutual agreement in writing as *International Agreements*. Potential areas of cooperation/collaboration include but are not limited to:

1. Collaborative educational programs and activities;
2. Conducting research and other scholarly activities in disciplines and on subjects of mutual interest and benefit;
3. Implementing faculty, staff and student exchanges, training and related activities;
4. Developing and implementing extension and technology transfer activities;
5. Implementing economic development projects, programs and activities;
6. Carrying out planning and institutional development;
7. Preparing and submitting grant, contract and other proposals to obtain resources to support collaborative activities; and
8. Other activities as may be mutually agreed.

Article III. Implementation of Collaborative/Cooperative Projects, Programs and Activities

Specific details of any cooperative/collaborative activities to be conducted will be described and agreed upon in writing as *International Agreements*. *International Agreements* will include the specific activities to be conducted; responsibilities of cooperating parties; personnel who will participate; sources, allocation and amount of sources; time; implementation procedures; and other details.

Article IV. Cooperation with Third Parties

Since other universities, institutes, centers and organizations may have capabilities and conduct activities, which will benefit and support this collaboration, the AUST and WSU may identify other cooperators for joint participation in mutually agreed upon projects and activities. The activities, responsibilities and other details of the participation of such cooperators will be defined and agreed in writing by the AUST, WSU and the third party institution in an *International Agreement*. This section does not in any way exclude or preclude either the AUST or WSU from individually executing agreements and conducting cooperative and collaborative research, education, economic development and other activities with other organizations independent of this Agreement and of each other.

Article V. Support and Resources

The amount and source of resources and other requirements for cooperative activities will be defined in the *International Agreements*. The AUST and WSU may jointly or individually seek funding and other support from third parties for the conduct of collaborative projects, programs and/or activities. This Agreement does not obligate either the AUST or WSU to provide funds and/or other resources from its own or other sources unless agreed in writing.

Article VI. Duration, Termination and Modification of Agreement

This Agreement shall take effect when signed by the official representatives of the institutions involved and will remain in effect for an initial period of *five (5)* years and may be extended by mutual agreement in writing for additional *five (5)* year periods. This Agreement may be terminated by either party with six (6) months written notice of intent to terminate. In the event of termination, each party will assume financial and other responsibilities for the completion of required and agreed activities or as such responsibilities may be modified by mutual written agreement. Any modification shall require the written approval of the President of Washington State University and the Vice-chancellor of Ahsanullah University of Science and Technology or their designees.

Article VII. Resolution of Disputes

The parties are committed to the informal and expeditious resolution of any dispute that arises between them related to or arising from any aspect of this Agreement or either party's performance of this

Agreement. If a dispute arises which the parties cannot resolve themselves, the matter shall be determined in the following way. Either party can request this process.

The parties shall form a dispute resolution panel consisting of three members. Each party shall choose one member and those two members shall mutually choose the third member in a manner that they determine. The panel shall determine its procedures. The guiding principal shall be an expeditious resolution of the dispute. There shall be no charge to any party for these services. The three members shall issue a written decision explaining the basis for their decision. The written decision shall be final and binding on the parties.

Article VIII. Contact Persons

Ahsanullah University of Science and Technology

M. H. Khan
Vice-chancellor
20 West Testuri Bazar Road, Tejgaon
Dhaka 1215, Bangladesh
Phone: 880-2-9130508
Fax:
E-mail:

Washington State University

Md. Akram Hossain
Associate Professor
Civil and Environmental Engineering
Richland, WA 99352-1671
Phone: (509) 372-7314
Fax: (509) 372-7471
E-mail: ahossain@tricity.wsu.edu

Article IX. Signatures

Ahsanullah University of Science and Technology

Approved by:

Mushaiq Hussain Khan Feb, 1, 2001

M. H. Khan, Vice-chancellor Date

Washington State University

Approved by:

V. Lane Rawlins, President Date

MEMORANDUM OF AGREEMENT

between

University of Houston
Cullen College of Engineering

and

Ahsanullah University of Science and Technology
Dhaka, Bangladesh

This *MEMORANDUM OF AGREEMENT (MOA)* is entered into by and between the University of Houston, Cullen College of Engineering (UH), which is a component of a state-supported institution of higher education that is located in Houston, Texas, U.S.A., and Ahsanullah University of Science and Technology (AUST), which is an institution of higher education that is located in Dhaka, Bangladesh. UH and AUST shall be known collectively as "the Parties" and singularly as "a Party" or "the Party."

RECITALS

WHEREAS, cordial relations exist between UH and AUST; and

WHEREAS, AUST and UH have discussed mutual goals regarding academic opportunities for students and faculty; and

WHEREAS, UH and AUST desire to establish a program for the benefit of students and faculty of their respective institutions.

NOW, THEREFORE, the Parties enter into this Memorandum of Agreement, in order to memorialize fundamental concepts regarding the program.

UNDERSTANDING OF THE PARTIES

In contemplation of establishment of the program, the Parties agree as follows:

ARTICLE I
Areas of Cooperation and Collaboration

A. ***Research Programs***. UH and AUST agree to cooperate in research programs in areas of mutual interest and benefit. The cooperation will be initiated by faculty members and research professionals (research associates, graduate students, etc.) working in areas of mutual interest, and be approved by the appropriate authorities in the two institutions. The details of each research project, as well as the arrangement of activities, will be discussed and agreed upon by the interested research groups. Financial support of a project and the individuals involved will be determined by the appropriate authorities of each institution for their respective participants.

B. ***Educational Assistance Programs***. According to the needs and opportunities available, UH and AUST agree to invite faculty members and research and other academic professionals to teach courses in each other's institution. These courses can be at the undergraduate or graduate (post graduate) level, and for a period of one semester or limited period of time according to the arrangement to be made between the interested departments. The host institution will initiate the invitation to the guest engineer or professor and be responsible for the necessary registration of students interested in the course. The financial compensation for teaching the course will be the responsibility of the home institution of the guest faculty member or professional.

C. ***Exchange of Scholars***. According to the needs of research programs, researchers from each institution may spend a period of time to participate in an ongoing research project at the other institution. The arrangement for

such exchange of scholars is to be administered by the departments involved, following appropriate guidelines and procedures of each institution. The authorities at each institution agree to encourage and support such exchange of scholars, to the extent possible based upon available funds and resources.

D. ***New Initiatives.*** As the relationship of the Parties develops, new initiatives may be identified for mutual cooperation and collaboration. The authorities at each institution agree to encourage and support such development of new initiatives, as governed by their respective institutional guidelines and procedures.

ARTICLE II
mplementation and Understanding of the Parties

A. UH and AUST agree to lend needed support to the implementation of this agreement and to encourage their departments to participate in the activities encompassed by it.

B. This MOA does not obligate either Party to provide funds and/or other resources from its own or other sources unless agreed in writing.

C. This MOA shall become effective upon the date of execution. It will remain in effect unless terminated by one of the Parties, upon written notice.

D. This MOA contains the entire understanding of the Parties at this time. If either Party is unwilling or unable to continue with plans for the program, that Party may do so by sending a written notice of regret to the other Party.

IN WITNESS, WHEREOF, the Parties have caused their fully authorized representatives to execute this Memorandum of Agreement on this, the _____ day of _____, 200___.

UNIVERSITY OF HOUSTON:

By: Edward P. Sheridan
Dr. Edward P. Sheridan
Vice President for Academic Affairs/Provost

Date: 4/23/02

By: Art Vailas
Dr. Art Vailas
Vice President of Research

Date: 4/22/02

By:
Dr. Raymond W. Flumerfelt
Dean, Cullen College of Engineering

Date: 3-27-02

By: Dennis P. Duffy
Mr. Dennis Duffy
University Counsel

Date: 9/22/2002

AHSANULLAH UNIVERSITY OF
SCIENCE AND TECHNOLOGY:

By: Mushtaq Hussain Khan
Dr. M. H. Khan
Vice-Chancellor

5. Annexure to the Bulletin

The Board of Post Graduate Studies of the Electrical and Electronic Engineering Department met on 14 November, 2015 and approved the following.

1. Course codes for M.Sc Engg./M.Engg thesis and project, respectively, are decided to be,
   EE 6000 (0-0-18) M.Sc. Engg.
   EE 6002 (0-0-6) M.Engg.

2. The EEE special topics course is named as,

   EEE 6999 (3-0-3) Special Topics in Electrical & Electronic Engineering

   Graduate faculty wishing to offer the course should propose detailed course syllabus and have it approved by the BPGS at least one semester prior to its offering. The course will contain graduate level course material in any discipline of Electrical & Electronic Engineering which is not included in the present syllabus. If there is a need for repeated offering of the course material, the Department should include it in a new course assigning a new course code.

3. **The following courses have been identified as core courses in the 4 major disciplines in EEE,**

EEE 6301	**Compound Semiconductor Devices (Electronics Group)**
EEE 6501	**Computer Methods in Power System Analysis (Power Group)**
EEE6701	**Advanced Communications Engineering (Communications Group)**
EEE6913	**Modern Control Theory (Interdisciplinary Group)**

   Students are required to take at least 3 out of the 4 core courses.

4. The graduate students should be able to switch between M.Sc. Engineering and M. Engineering programs with the permission of the Head of the Department and thesis advisor (if any). However, they should be discouraged to do so once they have crossed half of their credit requirements.
5. It was decided that final grade in a graduate course will be decided on the basis of following components the relative weights shown.

Assignments	15%
Mid-term Test	30%
Course Project	20%
Final Exam	35%

   However, there can be slight variation in the weights depending on the nature of the course.
6. The prerequisite for courses EEE 6511, and EEE6514 were suggested as:

   EEE 6511 Power System Stability (Pre-req: EEE 6501 or equivalent)

EEE6514 Smart Grid design and Application (Pre-req: EEE 6501 or equivalent)

The above was approved by the 15th Academic Council Meeting held on 7 January 2016. The meeting also approved membership of Drs. Quamrul Ahsan and Pran Kanai Saha to the BPGS of the EEE Department.