Postgraduate Program

Effective from
PG Session: 2020-2021

RUET

Department of Electrical & Electronic Engineering
Rajshahi University of Engineering & Technology

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Head of the Department

Editorial Board

Contributors

All PG Teachers of EEE Department

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Mailing Address
Head
Department of Electrical & Electronic Engineering
Rajshahi University of Engineering & Technology
Rajshahi-6204, Bangladesh
Phone: +880-2588866356
PABX: +880-2588866742- Ex.403 (HEAD)
Fax: +880-2588866356, IP Phone: 2312-403
Email: head@eee.ruet.ac.bd

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Department of Electrical & Electronic Engineering
Rajshahi University of Engineering & Technology
Rajshahi-6204, Bangladesh

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PREFACE

The Department of Electrical & Electronic Engineering (EEE) at Rajshahi University of Engineering & Technology (RUET) is pleased to present the syllabus booklet for our postgraduate programs, which are conducted based on both course and research work. The program syllabus and guidelines, including rules and regulations, are incorporated in this booklet for the information of present and prospective students, as well as faculty members of this university.

Our department is dedicated to producing competent engineers who can effectively tackle the local and global technological challenges in EEE fields. With a team of highly qualified teaching staff and comprehensive laboratory facilities, we aim to nurture individuals who become technology leaders worldwide upon graduation.

In order to maintain our leading position in generating technological leaders in EEE fields, it has become essential to update our curriculum based on worldwide requirements. Therefore, a significant revision has been made to the syllabus contents to incorporate recent advancements and developments in the field of Electrical & Electronic Technology.

This booklet also includes some general information about our university, such as its historical background, facilities, and details about the teaching department and university administration. We advise our students to keep in touch with their course adviser to stay informed about any changes that may occur.

We hope this syllabus booklet serves as a valuable guide throughout your academic journey with us, providing you with the necessary knowledge and skills for a successful career in Electrical & Electronic Engineering.

March 2024

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Chapter 1

ABOUT THE UNIVERSITY

The University

RUET is one of the four leading universities for engineering education in Bangladesh. It is the second oldest of the type established in 1964 as the center of excellence for higher studies, research and development in engineering and technology in Bangladesh. It was first named as Engineering College, Rajshahi (ECR) in 1964, upgraded to Bangladesh Institute of Technology, Rajshahi (BIT Rajshahi) in 1986 and finally as a full fledge university in September 2003.

Location

The university is located in the Motihar region of Rajshahi city. It is about five kilometers east from the city center and on the northern side of the Rajshahi-Natore-Dhaka highway. The university has an evergreen campus with mango, lichi, coconut, blackberry, and debdaru gardens on 152 acres of land.

The Campus

The RUET Campus is picturesque with its architecture and natural beauty. The campus area has been divided into different functional zones: (i) Residence for students, (ii) Residential zones for faculty and other supporting staff, (iii) Academic zone for academic buildings, laboratories, workshops, and (iv) Cultural cum social and recreational zones for students. A branch of Rupali Bank with an ATM booth, a post office, an auditorium, a central cafeteria, and a medical center are also located on the campus. There is Agrani School and College on the campus to facilitate the education of the children of university employees. A shopping center is situated near the student dormitories to meet the daily needs of the students. A barber shop and a laundry are also situated in close proximity to the center.

University Authority

The university has the following statutory committees for dealing student related affairs:

1) Syndicate
2) Academic Council
3) Dean's Executive Committee
4) Students Discipline Committee
5) Committee for Advanced Studies and Research (CASR)
6) Postgraduate Academic Committee (PGAC)
7) Undergraduate Academic Committee (UGAC)

ACADEMIC SUPPORT UNITS

Library Facilities

a) Central Library

The central library building is within the walking distance from the academic and residential buildings. It is a compact building with built-in facilities to provide the following services to the students and teachers.

i)Acquisition and processing of books and other printed and electronic materials.

ii) Issue and receipt of books.

iii) Research aid and Journal section.

iv) Reading room.

b) Rental Library

Each degree awarding department has its own rental library that provides books on rent to the students.

Students Health Service

An on campus medical center provides primary and basic health care facilities to the students (residential and non-residential) free of charges. Full-time MBBS doctors, nurses, and staffs provide these facilities to the students. For specialized consultation on complicated cases, the center refers the patients to specialist consultants.

Computer Center and Server Station

The central computer center plays an important role in the teaching and research of the students of different departments and provides useful services in data processing required in various sectors on national development. Each department also has separate computer laboratory where the students and the teachers of the respective departments can use computers for their thesis and research works. These computer centers are equipped with Pentium based machines operated under Windows and LINUX/UNIX operating system.

Directorate of Student Welfare

The Directorate of Student Welfare is responsible for various activities related to physical, mental, social, and other aspects for welfare of the students. These include regulating seat allocation process in the halls of residence, programs for physical education, games and sports, supervision of other co-curricular activities of students through the Central Students Union and through the students union of the various halls of residence. It is also responsible for providing health services to the students, arranging career fair, employment for students and to

organize and maintain contact with the alumni association of RUET, etc.

The Central Students Union, most of its meniers are clasted by the students, bridges between students need and policy making authorities of the university. Unions of the various residential halls also arrange their individual socio-culture activities, literary competitions etc. and help hall authority in normal functioning of the halls.

Games and Sports Facilities

The sports center of RUET provides excellent facilities to students for acquiring physical fitness that is indispensable for a healthy mind and body. The institute maintains both outdoor and indoor gaming and gymnasium facilities for the students. There is a beautiful playground for outdoor games like football, volleyball and cricket, two tennis lawns and a basketball court. The center arranges a colorful athletic competition every year in the form of annual sports meet.

For improvement of the standard of games and sports, regular coaching by experts is arranged. The institute arranges inter-year, inter-departmental football, cricket, basket-ball and volleyball competitions. Teacher student friendly games are also arranged at occasions.

Students Halls of Residence

There are seven halls of residence at the campus. The total capacity of these halls is about 2100. Followings are the halls with their respective capacities. Some of the halls are named after the national Heroes, students of ECR, who have sacrificed their lives in the liberation war of Bangladesh in 1971 and legendary leaders of the country.

The existing capacity is around 40% of the total number of students of the university. Non-residential students are to be attached with a hall so that the administrative control on the students becomes easy.

Serial No	Name of the Halls	Residencial Capacity
1.	Shahid Lt. Selim Hall	350
2.	Shahid Shahidul Islam Hall	225
3.	Shahid Abdul Hamid Hall	225
4.	Tin Shed Hall (Extension)	100
5.	Deshratna Sheikh Hasina Hall	250
6.	Shahid President Ziaur Rahman Hall	450
7.	Bangabandhu Sheikh Mujibur Rahman Hall	450

All halls are set in gardens and frontal green plantations and lawns and within easy walking distance of the academic buildings. The students live in these halls on community basis, while a single room depending on its size is shared by 2, 3 or 4 students. Each hall has a common room facility A provost and few assistant provosts administrate each hall.

Auditorium Complex and Seminar Hall

The university has an Auditorium Complex with modern facilities having a seating capacity of about 720 which is capable of holding conferenste, seminar and other extracurricular activities. Beside this, there is an air- conditioned conference hall with capacity of 60 in the Academic Building I. In addition, major departments have their own seminar halls.

ACADEMIC FACULTIES AND DEPARTMENTS

The teaching departments are grouped in under four faculties. Presently there are 14 departments offering undergraduate degrees and 13 departments offering graduate/post graduate (Master/PhD) degrees. Departments under the faculty of applied science and engineering do not offer undergraduate programs. They only run post graduate programs and teach corresponding courses to undergraduate degree awarding departments.

Faculties

Faculty of Civil Engineering
Department of Civil Engineering (CE)
Department of Architecture (ARCH)
Department of Urban & Regional Planning (URP)
Department of Building Engineering & Construction Management (BECM)

Faculty of Electrical & Computer Engineering
Department of Electrical & Electronic Engineering (EEE)
Department of Computer Science & Engineering (CSE)
Department of Electronics & Telecommunication Engineering (ETE)
Department of Electrical & Computer Engineering (ECE)

Faculty of Mechanical Engineering
Department of Mechanical Engineering (ME)
Department of Glass & Ceramic Engineering (GCE)
Department of Industrial & Production Engineering (IPE) Department of Mechatronics Engineering (MTE)
Department of Materials Science & Engineering (MSE)
Department of Chemical Engineering (ChE)

Faculty of Applied Science & Humanities
Department of Mathematics
Department of Physics
Department of Chemistry
Department Humanities

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

The Department

The department buildings are located at the eastern side of the campus. It has one building. There are about 1000 students, 45 teachers, 28 officers and staffs. The department has both undergraduate and post graduate programs and awarding both the degrees regularly. It has sixteen well- established modern equipment enriched laboratories, a rental library for students where various departmental books and journals are available on rent, a conference hall, and several multimedia class rooms. It gives awards to outstanding students of the department including the Joynal Memorial Award of the university.

There is an association named Association of Electrical & Electronic Engineering in the department. All teachers and students of the department are members of the association. It arranges sports, seminars, and other co- curricular activities on behalf of the department. The department plays a vital role in solving/serving the local and national industrial problems/needs by providing testing and consulting facilities.

List of PG of EEE, RUET Members

Dr. Muhammad Abdul Goffar Khan
Professor
B.Sc. Eng. (RU), M.Sc. Engg. (BUET), Ph.D (IITK, India)
Field of Specialization: High Voltage Engineering

Dr. Md. Rafiqul Islam Sheikh
Professor
B.Sc. Engg. (BITR), M.Sc. Engg. (BITR), Ph.D (Japan)
Field of Specialization: Smart Grid and Renewable Energy

Dr. S. M. Abdur Razzak
Professor
B.Sc. Engg. (BITR), M.Sc Engg. (RUET), M. Engg. and Ph.D (Japan)
Field of Specialization: Photonics and Optical Fiber System

Dr. Md. Zahurul Islam Sarkar
Professor
B.Sc. Engg. (BITR), M.Sc. Engg. (BITR), Ph.D (UK)
Field of Specialization: Wireless Communication

Dr. Ajay Krishno Sarkar
Professor
B.Sc. Engg. (BITR), M. Engg. (Japan), Ph.D (Australia)
Field of Specialization: RF and Microwave Devices, Biomedical and Sports Engineering

Dr. Md. Faruk Hossain
Professor
B.Sc. Engg. (BITR), M.Sc. Engg. (RUET), M. Engg. and Ph.D (Japan)
Field of Specialization: Nano Technology and Photovoltaics

Dr. Md. Shamim Anower
Professor
B.Sc. Engg. (BITR), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Underwater Communication

Dr. Md. Shahidul Islam*
Professor
B.Sc. Engg. (BITC), M.Sc. Engg. (BUET), Ph.D (RUET)
Field of Specialization: Nano Materials and Fabrication

Dr. Md. Selim Hossain
Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Antenna Array Signal Processing

Dr. Md. Masud Rana
Professor
B.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Computational Electromagnetics

Dr. Md. Sohel Rana
Professor
B.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Control Theory and Applications

Dr. Abdul Khaleque
Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Photonics

Dr. Md. Samiul Habib
Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Metamaterials

Dr. Tanvir Ahmed
Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Nonlinear Optics

Dr. G. K. M. Hasanuzzaman
Associate Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Cyprus)
Field of Specialization: Microwave Photonics and Integrated Optics

Dr. Abu Sadat Md. Sayem
Associate Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Wearable Antennas

Dr. Jishan-E-Giti
Associate Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Wireless Communication

Dr. Mohammod Abdul Motin
Assistant Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Biomedical Signal Processing and Machine Learning

Dr. Sumaiya Kabir
Assistant Professor
B.Sc. Engg. (RUET), M.Sc. Engg. (RUET), Ph.D (Australia)
Field of Specialization: Microelectronic Fabrication and Design

(*) On leave

Laboratory Facilities

The department provides adequate laboratories, library and other facilities to its members and students. The departmental undergraduate courses are augmented by intensive laboratory works in the name of sessional courses based on its theoretical parts and this requirement is catered by the following laboratories.

1. Computer Systems and Simulation Laboratory
2. Embedded System and Control Laboratory
3. Electrical Machines and Drives Laboratory
4. Electronics and Power Electronics Laboratory
5. Electrical Workshop and Design Laboratory
6. Fiber Optics and Photonics Laboratory
7. High Voltage and Switchgear Laboratory
8. Measurement and Instrumentation Laboratory
9. Microwave and Telecommunication Laboratory
10. Nanotechnology and Nanofabrication Laboratory
11. Renewable and Green Energy Laboratory
12. Radar and Satellite Laboratory
13. Firmware Engineering and IoT Laboratory
14. Biomedical Laboratory
15. Processing and Learning Laboratory
16. Solar Cell Testing Laboratory
17. Computational Photonics and Laser Laboratory

Electrical & Electronic Engineering Association

To facilitate academic and extra-academic activities of the students and teachers of the department there is an 'Electrical & Electronic Engineering Association' consisting of faculty members and students. The Association works under the direct supervision and guidance of the Head of the Department. The major source of the Association fund is contribution made by the department students and the teachers. The head of the department nominates one faculty member to act as honorary treasurer of the association.

Chapter 2

Academic Ordinance for Postgraduate Studies

(Recommended in 114th Academic Council held on 23.02.2021 and approved in 92nd Syndicate held on 04.05.2021)

1. Definitions

1.1 '**University**' means Rajshahi University of Engineering & Technology abbreviated as RUET.
1.2 '**Syndicate**' means the Syndicate of the University.
1.3 '**Academic Council**' means the Academic Council of the University.
1.4 '**CASR**' means the Committee for Advanced Studies and Research of the University.
1.5 '**PGAC**' means the Post Graduate Academic Committee in a degree awarding department of the University.
1.6 '**DSC**' means the Doctoral Scrutiny Committee.

2. Programs and Degrees Offered

The postgraduate (PG) programs of the University include Master's Program and Doctoral Program. Master's program includes Master of Science, Master of Engineering and Master of Philosophy. The doctoral program only offers Doctor of Philosophy. The PG degrees to be offered under this ordinance are as follow:

2.1 Master of Science in

i) Civil Engineering abbreviated as M. Sc. Engg. (CE).
ii) Electrical & Electronic Engineering abbreviated as M.Sc.Engg. (EEE).
iii) Computer Science and Engineering abbreviated as M.Sc. Engg. (CSE)
iv) Electronics & Telecommunication Engineering abbreviated as M.Sc.Engg. (ETE).
v) Glass and Ceramic Engineering abbreviated as M.Sc.Engg. (GCE).
vi) Industrial and Production Engineering abbreviated as M.Sc. Engg. (IPE)
vii) Mechanical Engineering abbreviated as M.Sc. Engg. (ME).
viii) Mathematics abbreviated as M. Sc. (Math)
ix) Physics abbreviated as M. Sc. (Phy)
x) Chemistry abbreviated as M. Sc. (Chem)

2.2 Master of Engineering in

i) Civil Engineering abbreviated as M. Engg. (CE).
ii) Electrical & Electronic Engineering abbreviated as M.Engg. (EEE).

iii) Computer Science and Engineering abbreviated as M. Engg. (CSE)
iv) Electronics & Telecommunication Engineering abbreviated as M.Engg. (ETE).
v) Glass and Ceramic Engineering abbreviated as M.Engg. (GCE).
vi) Industrial and Production Engineering abbreviated as M.Engg. (IPE)
vii) Mechanical Engineering abbreviated as M.Engg. (ME).

2.3 Master of Philosophy in

i) Mathematics abbreviated as M. Phil (Math)
ii) Physics abbreviated as M. Phil (Phy)
iii) Chemistry abbreviated as M. Phil (Chem)

2.4 Doctor of Philosophy

The degree of Doctor of Philosophy abbreviated as Ph. D. shall be offered by the department of:

i) Civil Engineering
ii) Electrical & Electronic Engineering
iii) Computer Science and Engineering
iv) Electronics & Telecommunication Engineering
v) Glass and Ceramic Engineering
vi) Industrial and Production Engineering
vii) Mechanical Engineering
viii) Mathematics
ix) Physics
x) Chemistry

3. Admission Requirements

3.1. A candidate must have a minimum GPA of 3.5 in the scale of 5.0 or its equivalent in the pre-university examinations.

3.2. (a) A candidate must have a B. Sc. Engg. or an equivalent degree from any recognized University/ Institute in the relevant/ related field with a minimum CGPA of 2.75 in the scale of 4.0 or its equivalent.

3.3. (b) For admission to the M.Sc./M.Phil programs offered by the faculty of Applied Science & Humanities of the University, a candidate must have an B. Sc. (M.Sc for M.Phil) or equivalent degree from any recognized University/ Institute in the relevant/related field with a minimum CGPA of 2.75 in the scale of 4.0 or its equivalent in all levels of the University/Institute.

3.4. For admission to the Ph. D. program, a candidate must have an M. Sc. Engg./M. Engg./M.Sc/M. Phil or an equivalent degree in the relevant branch from any recognized University/Institution with a

minimum CGPA of 3.00 in the scale of 4.0 or its equivalent.

3.5. If the supervisor(s) is satisfied with his/her research work, a student in M. Phil program of this University may be transferred to the Ph.D. program with retrospective registration using the prescribed form on recommendation of the supervisor(s), relevant PGAC, CASR and with the approval of the academic council. But for such transfer, the student must complete the course work requirements for a Ph. D degree and publish at least two papers in peer reviewed reputed Journals. In case of such a transfer, the students shall normally apply at the end of his/her last semester of study.

4. Admission Procedure

4.1 Applications for admission shall be invited through regular means of advertisement and shall be received by the registrar through prescribed application form.

4.2 There shall be an admission Committee in each department as constituted by the respective PGAC. The admission committee will scrutinize the applications.

4.3 The eligible applicants may be required to appear in a written and/or oral test conducted by the admission committee formed by respective department. The committee, on the basis of the admission test result, will approve a list of prospective students for admission into the PG programs of the concerned department.

4.4 Full time teachers of RUET, who are applicants for admission to any PG program of the University, need not to sit forthe admission test.

4.5 Every selected candidate shall have to get himself/herself admitted/registered to the University within the prescribedtime limit on payment of prescribed fees.

4.6 Eligibility for the admission of foreign students shall be examined by the equivalence committee.

4.7 On recommendation of the PGAC and CASR the rules for admission into PG programs may be amended from time totime by the Academic Council.

5. Academic Regulations

5.1 There shall be two semesters, namely odd and even, in one academic year. Normally, odd semester will start in April and the even semester will start in October.

5.2 (a) For full time students, the minimum duration of the M.Sc.Engg., M.Sc., and M. Engg. degrees shall be three semesters. The M. Phil programs shall be four semesters. However, a candidate must complete all requirements for the M.Sc.Engg./M. Engg./M.Sc./M. Phil degree within five academic years from the date of his/her first enrolment.

(b) For part time students, the minimum duration of the M.Sc. Engg., M. Engg. and M.Sc. programs shall be four semesters. The M. Phil courses shall be five semesters. However, a candidate must complete all requirements for the M.Sc.Engg./M. Engg./M.Sc./M. Phil degree within five academic years from the date of his/her first enrolment.

5.3 (a) For full time students, the minimum duration of the Ph. D. course shall be six semesters. However, a student must complete all the requirements for the Ph. D. degree within seven academic years from the date of his/her first enrolment.
(b) For part time students, the minimum duration of the Ph. D. course shall be eight semesters. However, a student must complete all the requirements for the Ph. D. degree within seven academic years from the date of his/her first enrolment.

5.4 The courses to be offered in a semester shall be determined by the respective department.

5.5 Academic progress shall be measured in terms of credit hours earned by a student. One credit hour for theory course shall normally require one hour of class attendance per week in a semester. While one credit hour for thesis, project and laboratory classes should normally require three hours of work per week in a semester.

5.6 Status of a student

5.6.1 There shall be two categories of students, namely -

(i) Full time: A full time student will not ordinarily be a full time/part time employee of any organization. However, the employee of any organizionsation may be admitted as a full time student only if he/she is on study leave or deputation from his/her organization for the entire program duration. A full time student may be awarded teaching/research assistantship in this University.

(ii) Part Time: A part time student is a student who is a part time/full time employee of any organization. He/she must submit a permission letter from the employer during admission. A part time Ph. D. student shall have to take leave from his/her employer, for at least two semesters (not exceeding one Calendar year) for the program; and he/she must join the program with the approved leave not later than the beginning of their fourth semester.

5.6.2 The PGAC of the department may allow a student to switch from part time to full time or vice versa upon submission of valid document(s) by a student in favour of his/her unengagement/unemployment to any part time/full time job at any organization. The concerned department will inform the controller of examination for such a change in the status of the students.

5.6.3 The concerned PGAC may permit a PG student to withdraw his/her name from the program for a total period of five academic years for Ph. D. program and three academic years for M.Sc. Engg./M. Engg./ M.Sc./M. Phil programs on the recommendation of the supervisor (if any)/course advisor. Such withdrawal period will be assessed as academic exmption and will be ignored for the calculation of total academic years spent by the student to complete the course.

5.7 Course Registration

5.7.1 Every registered student shall be assigned a course advisor by the Head of the department. The course advisor shall be a full time teacher of the department and not below the rank of an Assistant Professor having a Ph. D. or equivalent degree. Students shall seek advise from his/her course advisor whenever necessary on any mater related to the PG program.

5.7.2 Every student shall have to register the course(s) of the current semester within the prescribed time limit with approvalfrom his/her course advisor/ supervisor.

5.7.3 A full time student can register a maximum of 15 credit hours of the theory course per semester.

5.7.4 A part time student can register a maximum of 9 credit hours of the theory courses per semester.

5.8 A student may be allowed to register theory courses offered by other departments of this University on approval of the supervisor, the concerned Head, and the course teacher(s), as follows:

Degree	Maximum allowable Theory Course	Maximum allowable Credit hours
M. Sc. Engg	2	6
M. Engg	3	9
M.Sc.	2	6
M. Phil	3	9
Ph. D	1	3

5.8 Credit Transfer

After the first semester the respective PGAC may consider a student's application to transfer the credits earned elsewhere if the following conditions are fulfilled:

i. The credits should be earned from a recognized University or Institution.
ii. A maximum of 50% Credit-Hours in course work may be transferred.
iii. Credits earned before five academic years from the date of application will not be considered.
iv. Only B+ or higher grades will be counted.

5.9 Requirements for Continuation of a Program

5.9.1 If 'F' grade is obtained in three or more subjects by a student in any semester, he/she will not be allowed to continue the program.

5.9.2 If at the end of the 1st semester, the GPA of a student falls below 2.50 (including C grades) he/she will not be allowed to continue the program.

5.9.3 Termination of studentship from a program of a department due to Articles 5.9.1 and/or 5.9.2 shall not obstruct him/her to seek admission to the same or another post graduate program of the university following due procedures.

5.9.4 If a Ph. D. student fails to qualify the comprehensive examination in two chances, he/she shall not be allowed to continue the program.

5.10 Minimum Credit Hour Requirements for the Degree

Minimum requirements of the theory and thesis/project credit hours to be earned by a student for different degrees are as outlined in the following table:

Degree	Theory	Thesis	Project	Total
M. Sc. Engg	18	18	-	36
M. Engg	30	-	6	36
M. Sc.	18	18	-	36
M. Phil	24	24	-	48
Ph. D	9	45	-	54

6 Grading System

6.1 Letter grade system will be applied in assessment of the performance of a student in semester examination. Numerical marking may be made in answer scripts but all final gradings to be reported to the Head of the department in prescribed form, shall be in the letter grade as outlined below:

.Marks obtained	Grades	Description	Grade Points
90% and above	A+	Excellent	4.0
80% to below 90%	A	Very good	3.5
70% to below 80%	B+	Good	3.0
60% to below 70%	B	Average	2.5
50% to below 60%	C	Pass	2.0
Below 50%	F	Fail	0.0
	S	Satisfactory	
	U	Unsatisfactory	
	W	Withdrawn	

6.1.1 Courses in which a student gets 'F' grades shall not be counted towards credit hour requirements and for the calculation of Grade Point Average (GPA).

6.1.2 If a student registers a course in a semester but unable to sit for the examination due to unavoidable reasons, his/her course will be considered as 'withdrawn' and a grade 'W 'will appear in the grade sheet if he/she applies before commencement of the examination with valid documents and taking prior consent of the respective course teacher. If he/she does not apply and remain absent in the examination, he/she will get 'F' grade in that subject.

6.1.3 Satisfactory (S) and unsatisfactory (U) grade shall be used only as final grade for thesis/ project and non-credit courses.

6.2 Calculation of GPA and CGPA

Grade Point Average (GPA) is the weighted average in a semester and is calculated as

$$GPA = \frac{\sum_{i=1}^{n} C_i G_i}{\sum_{i=1}^{n} C_i}$$

where n is the number of courses completed by the student in a semester with grades not less than C, C_i is the credithour in a particular course and G_i is the grade point corresponding to the grade obtained by the student in that course. A Cumulative Grade Point Average (CGPA) shall also be computed at the end of second and subsequent semesters. CGPA gives the cumulative performance of the student; and is computed by taking n in the above equation as the total number of courses completed by the student from first semester up to any other semester to which it refers.

Both GPA and CGPA will be rounded off to the second place of decimal for reporting.

7. Conduct of Examination of Theory Courses

7.1 In addition to class tests, assignments and/or examination during the semester as may be given by the teachers(s) concerned, there shall be a written examination at the end of the semester for each of the courses offered in that semester. The dates of such examination will be announced by the Head of the respective department at least two weeks before the commencement of the examinations. The final grade in a subject shall be based on the performance in all tests, assignments and/or examinations.

7.2 The respective teacher(s) of each theory course offered in a semester will be the paper setter and script examiner for the semester examination.

7.3 The respective course teacher will submit the final grades obtained by the student(s) in his/her course in a prescribed form to the Head of the department and will also submit a copy of the same to the Controller of Examination of the University.

7.4 The Controller of Examination shall keep up-to-date record of all including the grades obtained by a sudent in individual Academic Record Card and shall announce the same at the end of each semester. Students may collect a copy of transcript from the Controller of Examination at the end of the program, on payment of prescribed fees. However, the copy of the Academic Record Card may be given to the students, on payment of prescribed fees.

8. Qualifying Requirements

8.1 The qualifying requirement for the postgraduate degree is that a student must earn a minimum CGPA of 2.75 for M. Sc. Engg/ M. Engg./M.Sc./M. Phil and 3.00 for Ph. D.

8.2 The C grades up to a maximum of two subjects may be ignored for calculation of CGPA at the written request of the student provided he/she has fulfilled the total course credit hours requirement and CGPA excluding the two above mentioned subjects.

8.3 In addition to successful completion of course work every student shall submit a thesis on his/her research work or a report on his/her project work fulfilling the requirements as detailed in Articles 5.10.

8.4 M.Sc/M.Sc.Engg/ M. Phil. students must have at least one peer reviewed reputed journal/reputed conference paper from part of his/her thesis work.

8.5 Ph. D. students must have at least three reputed conference papers and should have at least two journals from his/her thesis work in peer reviewed reputed journals.

9. Thesis/Project for M.Sc. Engg./M. Engg./M.Sc./M. Phil Program

9.1 Research work for a thesis/project shall be carried out under the supervision of a full time teacher of the department, not below the rank of Assistant Professor having a Ph. D. degree. PGAC of the department will appoint a supervisor for a student in the middle of first semester. A co-supervisor (if necessary) from within or outside the department/University may also be appointed. The appointment of the supervisor and co-supervisor (if any) shall be approved by the CASR as stated in Article 9.5.

9.2 If any change in the supervisor and co-supervisor (if any) is unavoidable, it should be approved by the academic councilon recommendation of the PGAC. In such a case, if the student fails to complete the program within the specified time limit as outlined in Article 5, the student may get an extension for not more than one academic year.

9.3 The research work must be carried out in this University. In special circumstances it may be carried out at a place(s) recommended by the supervisor in consultation with the Head of the department and approved by the CASR.

9.4 (i) An open seminar shall be conducted by each student to show his/her research work after the appointment of supervisor according to Article 9.1. The respective supervisor will send a report of it to the Head of the department. The Head of the department will keep a record of it.

(ii) A second open seminar shall be conducted by each student to show his/ her final outcomes before the oral examination for thesis/project. The respective supervisor will send a report of it to the Head of the department. The Head of the department will keep a record of it and send a copy to the controller of Examinations in prescribed form.

9.5 The complete research proposal, supervisor and co-supervisor (if any) shall be sent to the CASR for approval after completion of Article 9.4(i).

9.6 Examination Committee for M.Sc./M.Sc.Engg./M.Phil thesis: The supervisor, in consultation with the Head of the department shall propose to the Vice-Chancellor for the approval of Academic council a panel of examiners for thesis and oral examination, usually one month before the date of thesis examination. The Examination Committee shall be constituted as follows:

Supervisor	Chairman	
Co-Supervisor (if any)	Member	
Dean of the faculty	Member	
Head of the department	Member	
One external member from outside the department/ University not below the rank of Assistant Professor, having PhD degree.	External member	Two alternate namesshould be proposed.

One or two members from within or outside the department, not below the rank of Assistant Professor, having PhD degree.	Member	Three alternate namesshould be proposed.

9.7 Examination Committee for M. Engg. Project: The supervisor, in consultation with the Head of the department shall propose to the Vice-Chancellor for the approval of Academic council a panel of examiners for project and oral examination, usually one month before the date of project examination. The examination committee shall be constituted as follows:

Supervisor	Chairman	
Co-Supervisor (if any)	Member	
Dean of the faculty	Member	
Head of the department	Member	
One external member from outside the department/ University not below the rank of Assistant Professor, having PhD degree.	External member	Two alternate namesshould be proposed.
One or two member from within or outside the department, not below the rank of Assistant Professor, having PhD degree.	Member	Three alternate namesshould be proposed.

9.8 Every student shall submit to the Head of the department, through his/her supervisor a required number of printed copies of his/her thesis/project report in the prescribed format on or before a date to be fixed by the supervisor in consultation with the Head of the department concerned for the thesis/project examination.

9.9 The student shall certify that the research work was done by him/her and that the same work or part of it has not been submitted elsewhere for the award of any degree or diploma.

9.10 The thesis/project should demonstrate an evidence of satisfactory knowledge in the field of research undertaken by the student and must be an original contribution to engineering/science and worth of publication in peer reviewed journal/conferences.

9.11 Every student shall be required to appear at an oral examination, on a date or dates fixed by the supervisor in consultation with the Head of the department concerned and must satisfy the examiners that he/she is capable of intelligently applying the results of the research to the solution of problem, of undertaking independent work, and also afford evidence of satisfactory knowledge related to the theory and technique used in his/her research work.

9.12 If an examiner is unable to accept the appointment or has to relinquish his appointment before/during the examination, the Vice-Chancellor may appoint another examiner subject to the approval of Academic Council in his place in consultation with the Supervisor and Head of the department, without, further reference to the PGAC.

9.13 The Head of the department will keep a record of the thesis/project examination in his/her possession and send a copy of the report to the Controller of Examination in prescribed format, along with the comments (if any) of the thesis/project examiners.

9.14 For publication of the result, the Head of the department will send a confirmation letter to the Controller of Examinations stating that all the courses and other necessary requirements for the degree have been completed.

10. Thesis for Ph.D. Students

10.1 Thesis shall be carried out under the supervision of a full time teacher of the department, not below the rank of Assistant Professor having a Ph. D. degree. PGAC of the department will appoint a supervisor for a student in the beginning of his/her first semester. A co-supervisor (if necessary) from within or outside the department/University may also be appointed. The appointment of the supervisor and co-supervisor (if any) shall be approved by the CASR on recommendation of PGAC. Accordingly, the student will have to register his/her thesis course in the following semesters.

10.2 The Research work must be carried out in this University. In special circumstances it may be carried out at a place (s) recommended by the supervisor in consultation with the Head of the department and approved by the CASR.

10.3 A seminar shall be conducted by each student to show his/her preparation and tentative research plan at the beginning of his/her 2nd semester.

The PGAC will form a Doctoral scrutiny Committee (DSC). Every Ph.D. program student shall appear in a comprehensive examination conducted by the DSC at the end of the 2nd semester. The formation of the DSC is as follows:

Supervisor	Chairman	
Co-Supervisor (if any)	Member	
Dean of the faculty	Member	
Head of the department	Member	
One expert member with a Ph. D.degree in the relevant field not below the rank of Assistant Professor from outside the University	Expert member	Two alternate names should be proposed by the supervisor
Two members from within or outside the department, not below the rank of Assistant Professor having Ph. D.degree.	Member	Three alternate names should be proposed by the supervisor

The date and time of the comprehensive examination shall be fixed by the PGAC on the request of the supervisor.

10.4.1 The comprehensive examination shall comprise a written examination and/or an oral examination.

10.4.2 The DSC will examine that the candidate has a satisfactory knowledge related to the subject(s) of his/her research and closely related fields and the thesis theme is original and also conforms to the required standard for PhD course.

10.4.3 If a student fails to qualify in a comprehensive examination, he/she shall be given one more chance to appear in the examination as scheduled by the PGAC. The Head of the department will send a report of the comprehensive examination in prescribed form, to the Controller of Examination.

10.5 Following a successful comprehensive examination, the complete research proposal shall be sent to the CASR throughPGAC.

10.6 The student will present an open seminar before his final semester, showing the progress of the thesis work and will be evaluated by the DSC. The Head of the department will keep a record of these and send reports to the Contoller of Examination in prescribed form.

10.7 The student will present another open seminar before submitting his/her thesis, showing the progress and achievement of the thesis work and will be evaluated by the DSC.

10.8 Every student shall submit required number of printed copies of synopsis and the full Thesis in prescribed format to the Head of the department, through his/her supervisor. The head of the Department will send the synopsis to the controller of examinations and/or distribute those among the members of the examination committee.

10.9 The student shall certify that the research work was done by him/her and that the work has not been submitted elsewhere for a degree or a diploma.

10.10 The supervisor, in consultation with the Head of the department, will propose a panel of 6 experts in the related field of research from outside the department/University, at least 3 (three) from outside the country, to the Vice-Chancellor.

10.11 The Vice-Chancellor will select any two expert (one from outside the country) and instruct the Controller of Examination (CoE) to send copies of the synopsis to the selected experts, seeking their consent to be external examiner for the thesis. On receipt of their consent, CoE will send the copies of the thesis to them for evaluation and collection of their written opinion in prescribed form.

10.12 CoE will give copies of the experts' report to the student through the supervisor, if there are any further queries to be cleared or questions to be answered by the student. Such answers should be directly sent to the expert concerned by the CoE and final report should be collected.

10.13 On receipt of favorable experts' report, the supervisor in consultation with Head of the department shall propose to the academic council through CASR, a panel of examiners for thesis and oral examination usually one month before the date of thesis examination. The Examination Committee shall be constituted with the following members as described below:

Supervisor	Chairman
Other members of DSC	Members
One external members, from outside the University.	External Members

10.14 Every student submitting a thesis shall be required to appear at an oral examination, on a date or dates fixed by the supervisor in consultation with Head of the department. He/she must satisfy the examiners that he/she is capable of intelligently applying the results of this research to the solution of problems, of undertaking independent work, and also afford evidence of satisfactory knowledge related to the theory and technique used in his/her research work.

10.15 The thesis should demonstrate and evidence of satisfactory knowledge in the field of research undertaken by the student and must be an original contribution to engineering/science and worthy of publication.

10.16 If an examiner is unable to accept the appointment or has to relinquish his appointment before/during the examination, the Vice-Chancellor may appoint another examiner in his/her place from the panel, subject to the approval of academic council.

10.17 A student who has been transferred to the Ph.D. program from the M. Phil program may be awarded M. Phil degree, on recommendation of the supervisor, if the student fails to qualify for the award of the Ph.D. degree. In that case the student must have to fulfil all the requirements for the said degree.

10.18 The Head of the department will arrange to keep a record of the thesis examination in his possession and send a copy ofthe report to the Controller of Examination in prescribed format, along with the comments (if any) of the members of the examination committee. In this report he/she will also confirm that the student has completed the courses and other requirements (if any) for the award of the degree.

10.19 If a student fails to complete his/her degree in prescribed time limit, an additional academic year may be allowed by the academic council.

11. In case of an emergency (during any pandemic or similar crisis), PG academic activities e.g., classes, semester and thesis examinations, etc may be continued virtually. External examiner(s) from outside of the country can join academic activities of this university using online virtual platforms even in normal situations.

12. Cancellation of Studentship

i) Non-payment of dues within prescribed period.
ii) Failing to proceed with the program as prescribed by Article 5.9 of this ordinance.
iii) Forced to discontinue his/her studies under disciplinary rules.

13. Academic Fees

Academic fees will be prescribed by the appropriate authority of this University from time to time.

14. Effectiveness of this Ordinance

This ordinance will be effective from the batch of Postgraduate student admitted after the date of approval of this ordinance by the Syndicate.

15. Addition, Change and Deletion

The University authority can add new programs and change the ordinance (addition/deletion/modification) or part of itany time whenever it thinks necessary.

List of Courses

Course No.	Course Title	Credit
Compulsory Course		
EEE 6000	Thesis/Project	18
EEE 6001	Engineering Analysis	3
Elective Course		
EEE 6002	Selected Current Topics in EEE	3
Energy System		
EEE 6101	Energy Conversion	3
EEE 6102	Rural Energy System	3
EEE 6103	Renewable Energy	3
EEE 6104	Unconventional Energy Sources and Energy Converters	3
EEE 6105	Physical System Modeling	3
EEE 6106	Dye-sensitized Solar Cells	3
EEE 6107	Advanced Solar Cells: Technologies & Applications	3
Control System		
EEE 6201	Modern Control Theory	3
EEE 6202	Introduction to Adaptive Control	3
EEE 6203	Optimal Control Theory	3
EEE 6204	Robust Control Systems	3
EEE 6205	Digital Control Theory	3
EEE 6206	Multivariable Control System	3
EEE 6207	Microprocessor Based Industrial Control	3
EEE 6208	Artificial Neural Networks	3
Power System		
EEE 6301	Advanced Power System Analysis	3
EEE 6302	Advanced Power System Stability	3
EEE 6303	Optimization of Power System Operation	3
EEE 6304	Power System Planning	3
EEE 6305	Computer aided Power System Design	3
EEE 6306	Power System Reliability	3
EEE 6307	Power System Control and Instrumentation	3
EEE 6308	Power System transients	3
EEE 6309	Advanced Protective Relaying	3

EEE 6310	Generalized Machine Theory	3
Power Electronics and Dives		
EEE 6401	Power Electronics Converters I	3
EEE 6402	Power Electronics Converters II	3
EEE 6403	Electric Drives	3
EEE 6404	Modeling & Control of Electric Drives	3
EEE 6405	Power Electronics Application in Power Systems	3
Electronics		
EEE 6501	Integrated Circuit Technology	3
EEE 6502	Linear and Digital IC Application	3
EEE 6503	VLSI System Design	3
EEE 6504	Computer aided VLSI Design	3
EEE 6505	Gaseous Electronics	3
EEE 6506	Biomedical Electronics	3
EEE 6507	Advanced Optical Fibers	3
EEE 6508	Integrated Optics	3
EEE 6509	Thin Film Engineering	3
EEE 6510	Materials Engineering	3
Information, Telecommunication and Photonics		
EEE 6601	Information and Coding Theory	3
EEE 6602	Statistical Signal Theory	3
EEE 6603	Satellite Communication	3
EEE 6604	Data Communication	3
EEE 6605	Cellular Mobile Communication	3
EEE 6606	Optical Fiber System	3
EEE 6607	Optical Fiber Communication	3
EEE 6608	Advanced Digital Signal Processing	3
EEE 6609	Digital Circuit Design	3
EEE 6610	Digital Filter Design	3
EEE 6611	Digital Image Processing	3
EEE 6612	Fiber Optic Sensors	3
EEE 6613	Plasmonics and Optical Devices	3
EEE 6614	Adaptive Signal Processing	3
EEE 6615	Underwater Communication	3
EEE 6616	Biomedical Signal Processing	3
EEE 6617	Bioelectricity	3
EEE 6618	Underwater Acoustic Signal Processing	3

EEE 6619	Optical Network	3
EEE 6620	Advanced Optical Fiber Communication	3
EEE 6621	Numerical Methods & Fabrication Techniques in Photonics	3
EEE 6622	Nanophotonics: Fundamentals and Applications	3
EEE 6623	Biophotonics	3
EEE 6624	IoT Security	3
EEE 6625	Metasurfaces: Theory and Applications	3
Electromagnetic and Microwaves		
EEE 6701	Advanced Electromagnetic Theory	3
EEE 6702	Antennas and Propagation	3
EEE 6703	Computational Electromagnetic	3
EEE 6704	Microwave Solid State Devices	3
EEE 6705	High Power Microwave Devices	3
EEE 6706	Plasma Engineering- I	3
EEE 6707	Plasma Engineering- II	3
EEE 6708	Antenna Array Signal Processing	3
EEE 6709	Broadband Beamforming Processors	3
EEE 6710	Bioelectromagnetics	3
EEE 6711	Advance Microwave Circuit Design	3
EEE 6712	Relativistic Electron Beam Technology	3
EEE 6713	Fusion Science and Technology	3
EEE 6714	Electromagnetic Metamaterial	3
EEE 6715	Microwave Photonics	
Computer Aided Systems		
EEE 6801	Architecture of Microprocessor & Microcomputer	3
EEE 6802	Design and Organization of Microcomputer	3
EEE 6803	Computer Simulation Electrical & Electronic Circuits	3
EEE 6804	Computer in Electrical Engineering	3
EEE 6805	Computer aided Instrumentation and Sensor Application	3
EEE 6806	Computer aided Optoelectronic Application	3
EEE 6807	Computer aided Simulation of Physical Systems	3
EEE 6808	Introduction to Machine Learning	3
EEE 6809	Statistical Machine Learning	3
EEE 6810	Wearable Signal Processing and Machine	3

	Learning in Healthcare	
High Voltage Engineering		
EEE 6901	Behavior of Dielectric under High Voltage	3
EEE 6902	Insulators for High Voltage	3
EEE 6903	High Voltage Power Equipment Engineering	3
EEE 6904	Insulating Properties of Vacuum under High Voltage	3
EEE 6905	Insulating Properties of SF_6 under High Voltage	3
EEE 6906	HVDC Power Transmission	3

Detail Syllabus

Course No: EEE 6001
Course Title: Engineering Analysis

Credit: 3 Contact Hours/week: 3

Course Content:
Professional methods of dealing with problems. Mathematical and physical principles applied to problems of diverse topics in Electrical Engineering. Simulation Techniques; Statistical Methods.

Course No: EEE 6002:
Course Title: Selected Current Topics in EEE

Credit: 3 Contact Hours/week: 3

Course Content:
The respective instructor will determine the detailed syllabus.

Course No: EEE 6101
Course Title: Energy Conversion

Credit: 3 Contact Hours/week: 3

Course Content:
Energy conversion process; Direct electrical energy conversion; Electromechanical energy conversion; Electrical energy conversion from integrated renewable energy sources.

Course No: EEE 6102
Course Title: Rural Energy System

Credit: 3 Contact Hours/week: 3

Course Content:
Role of energy; Rural energy flow in developing countries; Energy demand- supply balance; Impact of rural energy flow on rural development and physical quality of life; Economic constraints for sustaining the energy flow; Rural energy system simulation for development planning.

Course No: EEE 6103
Course Title: Renewable Energy

Credit: 3 Contact Hours/week: 3

Course Content:
Solar constant, solar flux at the earth's surface, beam and diffuse solar flux, and solar beam angles. Direct methods of using solar energy, including solar-thermal, solar- thermal-electric, solar photovoltaic, and passive solar heating and lighting. Indirect methods of using solar energy, including wind turbines, hydro- electric, and biomass. Different manifestations of biomass utilization are discussed, including combustion

and biofuels. Hydrogen production from renewable energy, and the use of hydrogen in heat engines and fuel cells.

Course No: EEE 6104

Course Title: Unconventional Energy Sources and Energy Converters

Credit: 3 Contact Hours/week: 3

Course Content:

Review of various energy sources. Importance of unconventional sources such as solar, biogas, wind, tidal etc. Study of typical energy converters such as high performance motors, special generators driven by biogas engines, wind turbines etc. Mini-hydro generators. Modern state-of-the art and futuristic systems in this area.

Course No: EEE 6105

Course Title: Physical System Modeling

Credit: 3 Contact Hours/week: 3

Course Content:

Contact Hours/week: 3 Development of conceptual framework for physical system; Transformation of physical system into mathematical form; Protection and prediction of system response; System stability analysis; Controlling the system response; Policy prescription for optimum system response.

Course No: EEE 6106

Course Title: Dye-sensitized Solar Cells

Credit: 3 Contact Hours/week: 3

Course Content:

History Review of Conentional solar cells. Architecture of dye-sensitized solar cells. Working principle and energy diagram of DSCs. Fabrication of Working electrode & counter electrode. Light harvesting by monomolecular layers of photoinduced charge-separation at the dye/oxide interface. Electron transfer process in DSCs. Dye regeneration & recombination losses. Electrochemical potential & Mass transport in an electrochemical system. Charge-transfer over and electrode-electrolyte interface. Charge carrier percolation and collection. Photoelectrochemical characterizations of DSCs.

Course No: EEE 6107

Course Title: Advanced Solar Cells: Technologies & Applications

Credit: 3 Contact Hours/week: 3

Course Content:

Fundamental of Solar Cells, First, Second, and Third Generation Solar Cells: Quantum and Organic Solar Cells, Perovskite Solar Cells: Photophysics, Morphology optimization and Stability in perovskite solar cells, Lead free perovskite solar cells, Fourth Generation (Hybrid)

Solar Cells: current challenges and future prospectives, Plasmonic Solar cells, Contribution of Metal nanoparticles and oxides, Carbon nanotubes, Graphene and it's derivatives, Metamaterials for Solar Energy Harvesting, Comparison of the technologies and forecast for the future.

Course No: EEE 6201
Course Title: Modern Control Theory

Credit: 3 Contact Hours/week: 3

Course Content:
General introduction; State space concept; System design by state transition. method, Concept of controllability and observability. Optional control variational calculus method; Principle of maximum and dynamic programming. Stochastic and adaptive control processes. On-line computer control.

Course No: EEE 6202
Course Title: Introduction to Adaptive Control

Credit: 3 Contact Hours/week: 3

Course Content:
The underlying adaptive control schemes including Lyapunov based direct adaptive control scheme, self-tuning regulator and model reference adaptive control. Least squares estimate and the relevant issues in relation with parameter adaptation. Intelligent control; some simple iterative learning control schemes. Case studies of various engineering control problems will provide insight and useful design guideline

Course No: EEE 6203
Course Title: Optimal Control Theory

Credit: 3 Contact Hours/week: 3

Course Content:
The Optimal control problem. Cost functional. Use of calculus of variations. in optimal control. Optimization by Pontryagin's maximum principle and dynamic programming; applications. Linear regulator problems. Computational methods of solving two-point boundary value problems.

Course No: EEE 6204
Course Title: Robust Control Systems

Credit: 3 Contact Hours/week: 3

Course Content:
Linear Quadratic Regulators: return ratio & difference, sensitivity function. Kalman's optimality condition. Gain/phase margins, robustness to time delay and nonlinearity. Characterization of sensitivity. Kharitonov theorem robustness. Singular values - properties, application in stability,

robustness. and sensitivity. Robustness of discrete time Linear Quadratic Regulator (LQR) systems.

Course No: EEE 6205
Course Title: Digital Control Theory

Credit: 3 Contact Hours/week: 3

Course Content:
Discrete-time signals and systems, Z-transform, pulse transfer functions. Compensator design by root locus, error coefficients and frequency response. State-space models of discrete time systems, controllability, observability, stability, state estimation, Kalman filtering. Linear regulation. Parameter estimation.

Course No: EEE 6206
Course Title: Multivariable Control Systems

Credit: 3 Contact Hours/week: 3

Course Content:
Multivariable Systems: multivariable systems descriptions, zeros, poles and stability, Interaction and input-output paring. System Performance: performance specifications, system uncertainties, robust stability and performance. Frequency Domain Design: sequential loop design, characteristic locus method, Nyquist Array method. Optimal Design: Linear quadratic control, H-infinity control, predictive control.

Course No: EEE 6207
Course Title: Microprocessor Based Industrial Control

Credit: 3 Contact Hours/week: 3

Course Content:
Process Control Computer Systems Minis, micros, classification by hardware features and software facilities, performance evaluation techniques. Characteristics of Digital Processors Organization, instruction set, characteristics for process control, input/output arrangements, addressing techniques, memory systems. Process Control System Software: Review of availability of process control languages, application packages, operating system for real-time process control. System Selection Criteria: Specification, environment, hardware hardware and software requirements. Maintenance, procurement procedures, cost/ performance/availability ratios. Development Tools: Development systems for micros, software tools, logic analyzer, cross assemblers and compilers, simulators, emulators, in-house vs. turn-key trade off.

Course No: EEE 6208
Course Title: Artificial Neural Networks

Credit: 3 Contact Hours/week: 3

Course Content:
Introduction & Motivation; Biological Neural Networks and simple models; The Artificial Neuron Model; Hopfield Nets; Energy Functions and Optimization; Perceptrons & Threshold Logic machines; Multilayer Networks-their variants and Applications; Capacity of Mutilayer Networks; Backpropagation; Recurrent Nets; Tree Structured Networks; Unsupervised Learning; Hebbian Learning, Principal Component Analysis; Competitive Learning, Feature Mapping, Self Organizing Maps, Adaptive Resonance Theory. Hardware Realization of ANNs. Recent Trends and Future Directions.

Course No: EEE 6301
Course Title: Advanced Power System Analysis

Credit: 3 Contact Hours/week: 3

Course Content:
Algorithms for formation of bus admittance and impedance matrices. Power flow solutions Gauss Seidel, Newton Raphson, Fast decoupled power flow. Short circuit studies. Sparsity exploitation in power system studies. Static equivalents for power systems. Concepts of security states and security analysis in power systems. State estimation in power systems, Voltage stability analysis.

Course No: EEE 6302
Course Title: Advanced Power System Stability

Credit: 3 Contact Hours/week: 3

Course Content:
Voltage Stability: P-V and Q-V curves; Static analysis, sensitivity and continuation method; Dynamic analysis, local and global bifurcations; Control area, Margin prediction; Stability of AC-DC systems, Stability Analysis: Lyapnov's criteria, Energy functions for detailed & reduced order models, Stability boundary.

Course No: EEE 6303
Course Title: Optimization of Power System Operation

Credit: 3 Contact Hours/week: 3

Course Content:
General Principle of Optimization its application to power system planning, design and operation. Probability analysis for 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. Methods of optimum scheduling and dispatch of generator.

Course No: EEE 6304
Course Title: Power System Planning.

Credit: 3 Contact Hours/week: 3

Course Content:
Basic objective of power system planning; Generation expansion planning process. Electrical demand forecasting; Current demand forecasting approaches. Generating planning; economic analysis, expected energy generation, expected fuel cost, Booth-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; effect of load management of reliability on production cost. Joint ownership of generation.

Course No: EEE 6305
Course Title: Computer aided Power System Design

Credit: 3 Contact Hours/week: 3

Course Content:
Load flow study for large power system, optimal power flow studies, DOMMEL and TINNEY's method, digital computer methods of calculation of system generation schedule, computer controlled dynamic performance.

Course No: EEE 6306
Course Title: Power System Reliability

Credit: 3 Contact Hours/week: 3

Course Content:
Basic Probability Theory: Review of probability concepts. Probability distributions. Application of binomial distribution to engineering problems. Probability distribution in reliability evaluation. Network modeling and evaluation of simple and complex systems. System reliability evaluation using probability distributions. Frequency and duration techniques.

Generation System Reliability Evaluation: Concept of LOLP and E(DNS): Evaluation of these indices for isolated systems. Generation system. Reliability analysis using the frequency and duration techniques. Transmission System Reliability Evaluation: Evaluation of the LOLP and E(DNS) indices for an isolated transmission system. Distribution System Reliability Evaluation Reliability analysis of radial systems with perfect and imperfect switching.

Course No: EEE 6307

Course Title: Power Systems Control and Instrumentation

Credit: 3 Contact Hours/week: 3

Course Content:

Control of voltage, frequency and tie-line power flows, Q-v and P-f control loops. Mechanism of real and reactive power control.Net interchange tie- line bias control. Optimal, sub-optimal and decentralized controllers. Discrete-mode AGC. Time-error and inadvertent interchange correction techniques. On-line computer control. Distributed digital control. Data acquisition systems. Emergency control, preventive control, system wide optimization, SCADA.

Course No: EEE 6308

Course Title: Power Systems Transients

Credit: 3 Contact Hours/week: 3

Course Content:

Origin and nature of transients and surges. Surge parameters of plant. Equivalent circuit representations. Lumped and distributed circuit transients .Line energisation and de-energisation transients. Earth and earthwire effects. Current chopping in circuit breakers. Short line fault condition and its relation to circuit breaker duty. Trapped charge effects. Effect of source and source representation in short line fault studies. Control of transients. Lightning phenomena. Influence of tower footing resistance and earth resistance. Traveling waves in distributed parameter multiconductor lines, parameters as a function of frequency. Simulation of surge diverters in transient analysis. Influence of pole-opening and pole recolsing. Fourier integral and Z transform methods in power system transients. Bergeron methods of analysis and the use of the EMTP package.

Course No: EEE 6309

Course Title: Advanced Protective Relaying

Credit: 3 Contact Hours/week: 3

Course Content:

Advanced protective relaying, Basic protection schemes, relay terminology, relay as comparators, static relays, Application of solid state devices, differential relaying systems, distance relaying schemes, protection of multiterminal lines, new types of relaying criteria, special problems, digital protection.

No: EEE 6310

Course Title: Generalized Machine Theory

Credit: 3 Contact Hours/week: 3

Course Content:

Primitive machine representation, generalized torque equation, Park's transformation, de machine, induction machine and synchronous machine representation, Equivalent circuits and fault analysis.

Course No: EEE 640

Course Title: Power Electronics Converters I

Credit: 3 Contact Hours/week: 3

Course Content:

Power semiconductor devices: Structure, characteristics, ratings and protection. Single phase and 3-phase line commutated converters: Fully-controlled, half-controlled and dual converters. converters with improved performance. Single phase and 3-phase AC controller. cycloconverters. Static VAR compensators.

Course No: EEE 6402

Course Title: Power Electronics Converters II

Credit: 3 Contact Hours/week: 3

Course Content:

PWM ac-dc converter, PWM dual converter, Cycloinverters, Hybrid resonant dc-dc converters, Inverters for induction heating, resonant dc link inverters, dc-dc converters with different commutation schemes, PWM inverters, Switching dc power supplies power conditioners uninterruptible power supplies.

Course No: EEE 6403

Course Title: Electric Drives

Credit: 3 Contact Hours/week: 3

Course Content:

Motor Load dynamics. starting, Braking and speed control of DC and AC motors. DC drives; converter and chopper control. AC drives; Operation of induction and synchronous motors from voltage and current inverters. Transfer function and stability analysis Slip power recovery. Pump drives using AC line controller and self-controlled synchronous motor drives. Case study of Industrial drives.

Course No: EEE 6404

Course Title: Modeling & Control of Electric Drives

Credit: 3 Contact Hours/week: 3

Course Content:

Modeling of AC and DC motors. DC Drives; Cascade control structure, symmetric optimization of speed loop. AC Drives; self controlled synchronous motor drive, inverter and cycloconverter-fed drives. Scalar and Vector control schemes for speed and torque regulation, Drives for traction and other applications.

Course No: EEE 6405

Course Title: Power Electronics Applications in Power Systems

Credit: 3 Contact Hours/week: 3

Course Content:

Basics of flexible AC transmission systems, controlled rectifier and energy storage plants, Tap changers and phase shifters, Thyristor controlled VAR compensation and series compensation, modern (synchronous link converter) VAR compensators, unified power flow controller (UPFC) and interline power flow controller, power quality conditioners, power electronics in power generation.

Course No: EEE 6501

Course Title: Integrated Circuit Technology

Credit: 3 Contact Hours/week: 3

Course Content:

IC components - their characterization and design. Analysis and design of basic logic circuits. Linear ICs. Large Scale Integration. Computer simulation of ICs and layout design. High Voltage ICs. GaAs MESFET and GaAs ICs. Failure, reliability and yield of ICs. Fault modeling and testing.

Course No: EEE 6502

Course Title: Linear and Digital IC Applications.

Credit: 3 Contact Hours/week: 3

Course Content:

Linear IC applications, Combinational and sequential circuits; Available IC gates and flip-flops. Design of Combinatorial circuits using Karnaugh map; Counters and Shift registers; Active filters using OP Amps; Precision wave shaping circuits; Switching circuits using OP Amps, TTL and CMOS gates.

Course No: EEE 6503
Course Title: VLSI System Design

Credit: 3 Contact Hours/week: 3

Course Content:
Emphasis on the synthesis based approach to VLSI Design. Relevant issues related to physical design automation such as placement, floor planning, routing and compaction are covered. Combinational & sequential logic synthesis issues and algorithms are discussed. Detailed coverage of HDLS and high level synthesis algorithms and issues.

Course No: EEE 6504
Course Title: Computer aided VLSI Design

Credit: 3 Contact Hours/week: 3

Course Content:
Hardware Description Languages; Verifying behaviour prior to system construction simulation and logic verification; Logic Synthesis PLA based synthesis and multilevel logic synthesis; Logic optimization; Logic Simulation Compiled and event simulators; Relative advantages and disadvantages; Layout Algorithms Circuit partitioning, placement, and routing algorithms; Design rule verification; Circuit compaction; Circuit extraction and post-layout simulation; Automatic Test Program Generation; Combinational testing D Algorithm and PODEM algorithm; Scan-based testing of sequential circuits; Testability measures for circuits.

Course No: EEE 6505
Course Title: Gaseous Electronics.

Credit: 3 Contact Hours/week: 3

Course Content:
Introduction; Motion of gas particles. Excitation and Ionization of gases; Mobility, Diffusion, Recombination; Basic process of spark breakdown, Glow discharge, Are discharge, High frequency discharge, Tigger discharge. Electrical breakdown in vacuum; Triggered vacuum gap switches.

Course No: EEE 6506
Course Title: Biomedical Electronics.

Credit: 3 Contact Hours/week: 3

Course Content:
The need to study biological instrumentation; biological amplifiers and their interfacing with electrodes for activity monitoring solid state transducers for pressure flow, temperature and other physiological parameters and related instrumentation for long-term use. Low power consuming circuits especially for implantable pace makers; drift problem and its compensation, telemetry of biological signals. Digital signal

processing and imagery-construction suitable for scanning, for example, CAT, PET, NMR and ultrasonics with a special reference to instrumentation principles.

Course No: EEE 6507
Course Title: Advanced Optical Fibers

Credit: 3 Contact Hours/week: 3

Course Content:
Introduction to conventional optical fibers, Limitation of conventional optical fibers, Microstructure Optical Fibers (MOF), MOF construction, types, and fabrication techniques, MOFS optical properties, special purpose MOFS. MOF design, modeling and characterization.

Course No: EEE 6508
Course Title: Materials Engineering

Credit: 3 Contact Hours/week: 3

Course Content:
Historical Perspective; Impacts of Materials Engineering; Classification of Matericals; Advanced Materials; Modern Materials' Needs; Atomic Structure and Inter-atmic Bonding; The Structure of Crystalline Solids; Imperfections and Failure of materials; Mechanical, Electrical, Thermal, Optical, and Surface Morphological properties; Structures and Properties of Ceramics, Polymer, Composites; Corrosion and Degradation of Materials; Materials Selection and Design Considerations; Economic, Environmental, and Societal Issues in Materials Engineering.

Course No: EEE 6601
Course Title: Information and Coding Theory

Credit: 3 Contact Hours/week: 3

Course Content:
Entropy and mutual information, rate distortion function, source coding, variable length coding, discrete memory less channels, capacity cost functions, channel coding, linear block codes, cyclic codes. Convolution codes, sequential and probabilistic decoding, majority logic decoding, burst error-correcting codes.

Course No: EEE 6602
Course Title: Statistical Signal Theory

Credit: 3 Contact Hours/week: 3

Course Content:
Representation of deterministic signals: Orthogonal representation of signals. Dimensionality of signal spaces. Construction of orthogonal basis functions. Time-bandwidth relationship: RMS duration and bandwidth, uncertainty relations. Random Processes: Definition and classification,

stochastic integrals, Fourier transforms of random processes, stationary and non-stationary processes, correlation functions. Ergodicity, power spectral density, transformations of random processes by linear systems. Representation of random processes (via sampling, K-L expansion and narrow band representations), special random processes (white Gaussian noise, Wiener-Levy processes, shot-noise processes, Markov processes). Optimum Filtering: Matched filters for deterministic signals in white and colored Gaussian noise. Wiener filters for random signals in white and colored Gaussian noise. Discrete and continuous time filters.

Course No: EEE 6603
Course Title: Satellite Communication

Credit: 3 Contact Hours/week: 3

Course Content:
Introduction. Historical background and overall perspective; Satellite network modeling; Link calculations; FM analysis; TV Transmission; Digital modulation; Error control; Multiple access; FDMA, TDMA, CDMA. Orbital considerations; Launching; Transponders; Earth Stations; VSATS.

Course No: EEE 6604
Course Title: Data Communication

Credit: 3 Contact Hours/week: 3

Course Content:
Review of data communication techniques. Data transmission, line coding, error control coding. Data switching, circuit switching, message & packet switching. Network model ISO-OSI model, primitives and services. Elements of queuing. Data link control Simplex, pipelined and sliding window protocols, simplex performance analysis. X 25 data link layer. Random access techniques. Pure, slotted and finite population ALOHAS. Stability in ALOHAS. Routing and congestion control Static, adaptive, centralized and distributed routing procedures, congestion control. Local Area Networks LAN topologies and protocols, IEEE 802x protocols, implementation and performance issues. High speed LANS. Transport layer.

Quality of service, transport classes. Design issues, buffer management, synchronization. Session and presentation layer synchronization issues, formatting, data compression, data security.

Course No: EEE 6605
Course Title: Cellular Mobile Communication

Credit: 3 Contact Hours/week: 3

Course Content:
Mobile Radio Channel Modeling; Modulation Techniques; Cellular System Concepts; Equalization, Diversity and Channel Coding; Speech Coding; Multiple Access Techniques; Case Study: GSM, IS-95 and IMT2000 WCDMA.

Course No: EEE 6606
Course Title: Optical Fiber System

Credit: 3 Contact Hours/week: 3

Course Content:
Semiconductor Physics Radiative recombination. Light Sources: LEDs and Lasers. Light Modulators, Amplifiers, EDFA. Light Detectors: Photo diode, PIN, and APD.

Optical fibers - Mode theories, multimode and single-mode fibers, attenuation, dispersion, other loss mechanisms.

Advanced optical fibers, PCF, POF, their fabrication, properties and applications. Coupling and Splice, fault detections.

Course No: EEE 6607
Course Title: Optical Fiber Communication

Credit: 3 Contact Hours/week: 3

Course Content:
Fiber optic transmitter and receiver. Link analysis. Line Coding. Coherent optical communication systems. Multiplexing schemes. Optical networks: Local area networks, FDDI, SONET and SDH. Fiber optic sensors and signal processing. Optical Amplifiers, SOA. Photonic Switching. Design solutions in optical fibers. Optical interconnects, FTTH.

Course No: EEE 6608
Course Title: Advance Digital Signal Processing.

Credit: 3 Contact Hours/week: 3

Course Content:
Basic Digital Signal Processing:
Discrete time Signals and Systems, Digital signal processing fundamentals, ZT, IZT, Correlation, Convolution, DFT, FFT, Digital Filter Design.

Advanced Digital Signal Processing:
Application of basic digital signal processing, Multirate digital signal processing, Finite wordlength effects, Adaptive filters, Power spectrum

estimation, Advanced transform algorithms, DSP hardwares, Introduction to statistical digital signal processing, Multidimentional digital signal processing and Wave digital filters.

Course No: EEE 6609
Course Title: Digital Circuit Design

Credit: 3 Contact Hours/week: 3

Course Content:
The course will present advance techniques of digital circuit design. It will concentrate on the design of sequential circuits, micro programming viewed as a sequential circuit and fault tolerant design.

Basic review of Combinational circuit design using k-map, multiplexers and EPROMs. Introduction to sequential circuits; fundamental mode circuits.

Concept of state, construction of state diagrams. Event driven circuits using RS latch, multiplexers and EPROMS Clock driven circuits using JK flip- flops, counters and EPROMS. Microprogramming and use of AMD 2909 yasa microsequencer and sequential circuits. Reliable design theory and techniques. Some examples like Data Acquinition system, microprocessor peripheral interface, digital printer interface and DMA controller will be taken up.

Course No: EEE 6610
Course Title: Digital Filter Design

Credit: 3 Contact Hours/week: 3

Course Content:
Discrete time signals and systems Z transforms. Structures for digital filters. Designs procedures for FIR and IIR Filters.

Course No: EEE 6611
Course Title: Digital Image Processing

Credit: 3 Contact Hours/week: 3

Course Content:
Digital Image Fundamentals; Image Enhancement in Spatial Domain: Gray Level Transformation, Histogram Processing, Spatial Filters; Image Transforms: Fourier Transform and their properties, Fast Fourier Transform, Other Transforms; Image Enhancement in Frequency Domain; Color Image Processing; Image Warping and Restoration; Image A Compression; Image Segmentation: edge detection, Hough transform, region based segmentation;

Morphological operators; Representation and Description; Features based matching and Bayes classification; Introduction to some computer vision techniques: Imaging geometry, shape from shading, optical flow;

Laboratory exercises will emphasize development and evaluation of image processing methods.

Course No: EEE 6612
Course Title: Fiber Optic Sensors

Credit: 3 Contact Hours/week: 3

Course Content:
Overview and architecture of fiber optic sensors; Theory of fiber grating, In-Fiber grating Sensors, Distributed fibedr optic sensors, Polarimetric sensors, Fabry-Perot Interferometer based sensors, Fiber Gyroscope sensors; Optical Fiber Hydrophone systems, Characterization and applications of Fiber Optic sensors.

Course Title: EEE 6613
Course Name: Plasmonics and Optical Devices

Credit: 3 Contact Hours/week: 3

Course Content:
Plasmonics: Fundamental concepts underneath plasmonics, Surface plasmon polariton, Localized surface plasmon, Surface Plasmon Resonance, Key advantages and applications.

Plasmonic / Photonic materials: Tunable and active plasmonic materials, Fundamentals of Silicon/Diamond/Graphene photonics, Introduction to 2D material and their applications.

Plasmonic in Optical Devices: Plasmonic Meta-materials, Plasmonic metamaterial absorber, Nano-antennas, Modulators, Nano-wires, Optical Sensors, Plasmonic solar cells, Fiber based plasmonics devices (polarization controllers, polarization filters, polarization splitters, etc.).

Course Title: EEE 6614
Course Name: Adaptive Signal Processing

Credit: 3 Contact Hours/week: 3

Course Content:
Introduction : Adaptive Systems - Definition and Characteristics - Open- and Closed-Loop Adaptation - Adaptive Linear Combiner - Input Signal and Weight Vectors - Desired Response and Error - Performance Function.

Theory of Adaptation - Properties of the Quadratic Performance Surface - Normal Form of the Input Correlation Matrix - Eigenvalues and Eigenvectors of the Input - Correlation Matrix - Geometrical Significance of Eigenvectors and Eigenvalues.

Performance Surface - Methods of Searching the Performance Surface - Basic Ideas of Gradient Search Methods - simple Gradient Search Algorithm - Gradient Estimation and its Effects on Adaptation - Gradient Component Estimation by Derivative Measurement - Derivative Measurement and Performance Penalties with Multiple Weights.

Adaptive Algorithms - The LMS Algorithm - Derivation of the LMS Algorithm - Convergence of the Weight Vector - An Example of Convergence - Learning Curve Noise in the weight-Vector Solution.

Applications- Adaptive Modeling and System Identification - Adaptive Modeling of a Multipath Communication Channel. Inverse Adaptive Modeling Deconvolution and Equalization - General Description of Inverse Modeling- Adaptive Equalization of Telephone Channels - The Concept of Adaptive Noise Canceling - Stationary Noise-Canceling Solutions, Filtered-X LMS Algorithm - Adaptive Arrays - Sidelobe Cancellation - Beam forming with a Pilot Signal- Spatial Configurations, Adaptive Algorithms.

Course Title: EEE 6615
Course Name: Underwater Communications

Credit: 3 Contact Hours/week: 3

Course Content:

Adaptive Signal Processing: Adaptive Systems, Open Loop and Closed loop Adaptations, Adaptive Linear Combiner, Theory of Adaptation with stationary Signals, Adaptive Algorithms and Structures, Applications.

Applications of Digital Signal Processing to Sonar: Characteristics of Sonar Signal propagation, Digital signal Processing for active sonar system and digital signal processing for passive sonar systems, Signal Processing Hardware -TMS 320 Series Signal Processors, real-time implementation considerations.

Orthogonal Frequency division multiplexing: Key features, characteristics and principle of operation of OFDM, Channel coding and interleaving System model, Enhancement of spectral efficiencies, Transmission/ Reception of OFTD - OFDM Simulations.

Acoustic Modem: Underwater Wireless Modem- Sweep spread carrier signal-transmission characteristics in shallow water channel-separation of time varying multipath arrivals-Typical acoustics modems-characteristics and specifications- Applications, Acoustic Releases-Real time wireless current monitoring system.

Underwater Sensor Network: Underwater Networking- Ocean Sampling Networks, Pollution Monitoring, Environmental Monitoring and Tactical surveillance systems, Major challenges in design of Underwater Sensor Networks, Factors that affect the UWSN- Sensor Node Architecture- GIBS, VRAP, DABSRAPT. etc.

Course Title: EEE 6616
Course Name: Biomedical Signal Processing

Credit: 3 Contact Hours/week: 3

Course Content:

Signal, System and Spectrum: Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

Time Series Analysis and Spectral Estimation: Time series analysis – linear prediction models, process order estimation, non stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

Adaptive Filtering and Wavelet Detection: Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, EEG and other applications in Bio signals, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

Biosignal Classification and Recognition: Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats and other biomedical applications

Time Frequency and Multivariate Analysis: Time frequency representation, spectrogram, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA.

Course Title: EEE 6617
Course Name: Bioelectricity

Credit: 3 Contact Hours/week: 3

Course Content:
Introduction to Bioelectricity and Excitable Cells.

Bioelectric potentials and currents: ionic composition of excitable cells, Nernst-Planck equation, membrane structure, Nernst potential, parallel-conductance model;

Membrane channels: channel structure, biophysical methods for measuring channel properties, macroscopic channel kinetics, channel statistics, introduction to the Hodgkin-Huxley membrane model;

Action potentials: observing action potentials, nonlinear membrane behavior, origin of action potential, resting and peak voltages, voltage and space clamp, Hodgkin-Huxley equations, simulation of membrane action potential, action potential characteristics, active transport, calcium channels and "other" membrane models;

Impulse propagation: core-conductor model, cable equations, local circuit currents during propagation, mathematics of propagating action potentials, propagation velocity constraint for uniform fiber, propagation in myelinated nerve fibers;

Electrical stimulation of excitable tissue: linear (subthreshold) response of a single spherical cells, linear (subthreshold) response of a cylindrical fiber;

Extracellular fields: basic formulation, lumped fiber source models; cardiac electrophysiology, electrical nature of intercellular communication, source models, ECG measurement and analysis;

The Neuromuscular junction: structure of the neuromuscular junction, evidence for the quantal nature of transmitter release, Poisson statistics for transmitter release, the effect of Ca_2+ and Mg_2+ on transmitter release, post-junctional response to transmitter;

Skeletal muscle: muscle structure, muscle contraction, structure of the myofibril, sliding filament theory, Excitation-contraction, EMG measurement and analysis;

Neural electrophysiology: structure of the nervous system, sensory transducers and neurons, neural synapses, excitation and inhibition, neural coding and computation, EEG measurement and analysis, brain-computer interfaces;

Functional electrical stimulation: electrodes and electrode-tissue behavior, nerve excitation.

Course Title: EEE 6618
Course Name: Underwater Acoustic Signal Processing

Credit: 3 Contact Hours/week: 3

Course Content:

Underwater Acoustic Channel: Underwater Channel Characterization, Sound Transmission Losses, Acoustic Characteristics of surface layer, Ambient Noise in the ocean, Correlation properties of Ambient Noise.

Sonar: Basics of SONAR, Correlation and Ambiguities, Wideband Synthetic Aperture SONAR processing, Discrete Spatial arrays, Beam stearing, Target Angle Estimation, Array Shading.

Target Detection: Passive Acoustic signatures of Ships and Submarines, Target strength for Active Systems, Hypothesis testing, Receiver operating Characteristics, Estimation of signal Parameters.

Statistical Processing and Adaptive Spatial Filtering: Monostatic Sounding of Single point Targets, Target strength estimation from Echo ensemble, Optimum Filter for Maximum SNR, High Resolution Beam Forming.

Underwater Acoustic Communication: Underwater Bio Telemetry System, System Design principle, Speech Coding and Decoding, Transmission and Detection of speech.

Course Title: EEE 6619
Course Name: Optical Network

Credit: 3 Contact Hours/week: 3

Course Content:

Photonic network architectures: point to point, star, ring, mesh; system principles: modulation formats, link budgets, optical signal to noise ratio, dispersion, error rates, optical gain and regeneration; wavelength division multiplexed networks; WDM components: optical filters, gratings, multiplexers, demultiplexers, wavelength routers, optical crossconnects, wavelength converters, WDM transmitters and receivers; Wavelength switched/routed networks, ultra high speed TDM, dispersion managed links, soliton systems; broadcast and distribution networks, multiple access, subcarrier multiplexed lightwave video networks, optical local area and metropolitan area networks; protocols for photonic networks: IP, Gbit Ethernet, SDH/SONET, FDDI, ATM, Fibre Channel.

Course Title: EEE 6620

Course Name: Advanced Optical Fiber Communication

Credit: 3 Contact Hours/week: 3

Course Content:

Introduction:

Historical evolution of optical fibre communications, State of the art; WDM- Optical devices for WDM communications, Long haul and metro WDM systems, WDM systems analysis, design and performance evaluation;

Advanced modulation formats:

Multilevel modulation schemes, Orthogonal frequency-division multiplexing (OFDM), Polarization multiplexing, Constrained (line or modulation) coding, and Coherent detection.

Forward error correction (FEC):

Linear block codes and cyclic codes, BCH and RS codes, Concatenated codes, Turbo- and turbo-product codes, and LDPC codes.

Coded modulation schemes:

Multilevel coding, Bit-interleaved coded modulation, and Coded OFDM.

Advanced chromatic dispersion compensation:

Signal pre-distortion compensation, Post-detection compensation, Compensation of chromatic dispersion by OFDM. Advanced PMD compensation

Nonlinearity management:

Compensation of intrachannel and interchannel nonlinearities, Compensation of nonlinear phase noise, Digital back-propagation method, and Turbo equalization.

Optical switching, Parametric processes and applications:

Optical burst switching, Parametric amplifiers, All-optical regeneration.

Optical channel capacity:

Channel Capacity Preliminaries, Calculation of information Capacity, Information Capacity of Systems with Direct Detection, Information Capacity of Multilevel Systems with Coherent Detection, Capacity of Optical OFDM Systems, Channel Capacity of Optical MIMO MMF Systems, Noise sources, channel impairments, and optical transmission system design principles.

Course Title: EEE 6621
Course Name: Numerical Methods & Fabrication Techniques in Photonics

Credit: 3 Contact Hours/week: 3

Course Content:

Numerical Methods in Photonics: Finite Difference Method, Finite Difference Time Domain, Finite Element Method, Transfer Matrix Method, Beam Propagation Method, Finite Difference Frequency Domain, Method of Moment, Coupled Mode Theory.

Fabrication Technologies in Photonics: Optical Fiber Fabrication: Stack-and-Draw, Extrusion, 3D Printing. **Nano-Patterning:** Photolithography, Scanning Lithography (Electron Beam Lithography), Soft Lithography, Nano-imprint Lithography, Mask Alignment Technique, Hot-Embossing, 3D Focused Ion Beam (FIB) milling. **Physical Vapour Depositions:** Sputtering (DC, RF, Magnetron, Reactive Sputtering), Evaporation (Electron Beam Evaporation, Thermal Evaporation, Pulsed Lased Evaporation, Molecular Beam Epitaxy). **Chemical Vapour depositions (CVDs):** Metal Organic CVD, Plasma Enhanced CVD, Modified CVD, Atmospheric and Low-Pressure CVD, Laser-induced CVD, Atomic Layer Deposition. **Others:** Chemical Bath Deposition, Spray pyrolysis, Electroplating, Sol-gel spin-on techniques, Spin-cast. **Etching:** Dry Etching, Wet Etching. Lift-off Technique. **Metrology and Characterization:** Focused Ion Beam, Scanning Electron Microscopy, Atomic Force Microscopy, Measurement by Ellipsometer and Surface Profiler, Hall Effect System, Raman Imaging, X-ray Diffraction. **Implantation:** Ion Implantation. **Modification and Packaging:** Thermal Annealing, Flip-chip Bonding, Wire Bonding.

Course Title: EEE 6622
Course Name: Nanophotonics : Fundamentals and Applications

Credit: 3 Contact Hours/week: 3

Course Content:

Photons and Electrons: Similarities and Differences, Nanoscale Optical Interactions, Nanoscale Confinement of Electronic Interactions, Near-Field Optics and Microscopy, Study of Quantum Dots, Nanoscale Enhancement of Optical Interactions, Quantum Wells, Quantum Wires, Quantum Rings, Manifestations of Quantum Confinement, Metallic Nanoparticles and Nanorods, Metallic Nanoshells, Local Field Enhancement, Plasmonic Wave Guiding, Nanocontrol of Excitation Dynamics, Growth and Characterization of Nanomaterials, Nonlinear Photonic Crystals, Nanocomposites Meta-materials, Nanolithography, Biomaterials and Nanophotonics, Nanophotonic Energy Conversion, Nanophotonics for Biotechnology and Nanomedicine.

Course Title: EEE 6623
Course Name: Biophotonics

Credit: 3 Contact Hours/week: 3

Course Content:
Overview of Biophotonics, Fundamentals of Light-Matter Interactions, Fundamentals of Light Sources and Detectors, Basics of Biology, Photobiology (Light-Tissue Interactions), Optical Fibers for Biophotonics Applications, Bioimaging: Principles, Techniques and Applications, Optical Biosensors, Microarray Technology for Genomics and Proteomics, Flow Cytometry, Light-Activated Therapy: Photodynamic Therapy, Tissue Engineering with Light, Laser Tweezers and Laser Scissors, Bionanophotonics, Biomaterials for Photonics, Biophotonics Technology Applications.

Course Title: EEE 6624
Course Name: IoT Security

Credit: 3 Contact Hours/week: 3

Course Content:
Introduction:
Concept of information security, CIA triad, IoT architecture and security requirements, classification of IoT, traditional cyber security vs IoT security, basics of physical layer security (PLS), cryptography, machine-learning approach.

Threats and Vulnerabilities:
Threats on IoT, natural threats vs human caused attacks, attacks on hardware and networks (sensors, RFIDs, back-end systems etc.), smart application threats, risks and countermeasure, security attributes of the IoT communication protocols.

Cryptographic Security Approaches:
Key management, encryption and decryption, digital signature, hash function, cryptographic controls for various protocols, blockchain.

Physical Layer Security Approaches:
Analyzing system models, channels and related threats to implement physical layer security methods. Massive MIMO, NOMA, mmWave, full-duplex radio, EH, VLC and UAV communications.

Machine-Learning Approaches:
Threat intelligence (TI) techniques, AI driven models against cyber attacks, deep learning schemes.

Case Studies:
System model and threat analysis in various scenarios such as healthcare, military, smart city infrastructure, smart environment, autonomous driving etc.

Course Title: EEE 6625
Course Name: Metasurfaces: Theory and Applications
Credit: 3 Contact Hours/week: 3

Course Content:
Fundamentals of Metamaterials, Metasurfaces and Metastructures, Classification, Emergence, and Properties of Metasurfaces, Active and Passive Metasurfaces,Time Varying Metasurfaces, Additive Manufacturing Processes of Metasurfaces, Applications: Flat Optical Elements, Broadband and Perfect Absorbers, Colour Printing, Holograms, Polarimeters and Surface Wave Couplers, Nonlinear Metasurface, Wavefront Shaping and Beam Forming, Dielectric Metasurfaces, Active and Nonlinear Metasurfaces, Wave Guidance and Radiation Control, Light Bending and Focusing, Metalenses, Invisibility Cloaks, Metasurface Photodetectors, Metasurface Holograms, Tunable and Reconfigurable Metasurfaces, Topological Metasurfaces, Waveguide, Antennas and Microwave Circuits, Phase and Amplitude Modulation, Polarization Control, Tunable Homogeneous Metasurfaces, Gradient Metasurfaces: Principles and Realization, Applications of Inhomogeneous Metasurfaces, Future Opportunities and Challenges of Metasurfacs.

Course Title: EEE 6701
Course Name: Advanced Electromagnetic Theory
Credit: 3 Contact Hours/week: 3

Course Content:
Transmission line theory; Green's function and integral transform. techniques; Wave propagation and polarization parameters; reflection and transmission across an interface; waveguides, cavity resonators, scattering by cylinders, wedges, spheres etc. Geometric theory of diffraction EEE.

Course Title: EEE 6702
Course Name: Antennas and Propagation
Credit: 3 Contact Hours/week: 3

Course Content:
Fundamental of Antennas: Vector Potential Functions, Electric and Magnetic Fields for Electric and Magnetic Current Sources, Solution of Vector Potential Wave Equation.

Antenna Arrays: Two-Element Array, N-element Linear Arrays: Broad-side, End-fire, Phased, Binomial, Dolph- Tchebyschef and Super-directive Arrays, Determination of Array Factor and Patterns, Planar and Circular Arrays.

Travelling-Wave and Broad-band Antennas: Long wire, V, Rhombic and Helical Antennas, Yagi, Uda array, Frequency Independent and Log-periodic Antennas.

Aperture, Reflector and Lens Antennas: Huygens's Principle, Rectangular and Circular Apertures, Microstrip Antennas.

Babinet's Principle, Sectoral, Pyramidal and Conical Horns, Parabolic and Cassegrain Reflector Antennas, Lens Antennas.

Antenna Measurement: Antenna ranges, Radiation Pattern, Gain and Directivity, Polarization.

Radio wave propagation: Ground wave propagation, Ionospheric propagation, Propagation losses.

Course Title: EEE 6703
Course Name: Computational Electromagnetics

Credit: 3 Contact Hours/week: 3

Course Content:
Review of analytical methods: Separation of variables conformal transformation: Green's function. Finite difference method: Iterative solution: relaxation and acceleration processes: Finite difference time domain method (FDTD); different boundary conditions. Finite element method: Discretization of solution region: shape functions: element matrices and global matrix; method of solution. Method of moments; Basis functions; weighted residuals; method of least squares; numerical integration

Course Title: EEE 6704
Course Name: Microwave Solid State Devices

Credit: 3 Contact Hours/week: 3

Course Content:
Two terminal devices and circuits Junction diodes PIN, Schottky, Varactor, tunnel diodes. Design and analysis of switches, limiters, phase shifters, modulators, harmonic generators and parametric amplifiers. Transferred Electron Devices-Gunn, LSA. Avalanche Transit Time Devices-IMPATT, TRAPATT and their circuits. Bipolars, JFET and MESFET. Design of oscillators and amplifiers

Course Title: EEE 6705
Course Name: High-Power Microwave Devices

Credit: 3 Contact Hours/week: 3

Course Content:
Microwave amplifiers and oscillators; Principle of generation of millimeter and sub-millimeter waves from FAST WAVE devices (including FELS and Electron Cyclotron Masers), SLOW WAVE devices (including Klystrons, Magnetrons Cerenkov Masers, BWOS, RDGS and NWCGS), and PLASMA devices (including VIRCATORS and reditrons). Details study of electromagnetic Slow Wave Systems. General Properties of Slow Wave Structures, Analysis of Cold Slow Wave structures, Interaction of Electron Beam with Electromagnetic Field supported by Slow Wave Structures.

Course Title: EEE 6706
Course Name: Plasma Engineering I

Credit: 3 Contact Hours/week: 3

Course Content:
General Concepts of Plasma; Generation and Application of plasma; Single particle and collective nature of Plasma; Motion of charged particles in Electric and Magnetic Fields; Fluid Theory of Plasma; waves in unmagnetized magnetized plasmas; Diffusion and resitivity of Plasma.

Course Title: EEE 6707
Course Name: Plasma Engineering - II

Credit: 3 Contact Hours/week: 3

Course Content:
Equilibrium and stability of Plasma. Electron beam interaction with plasma; amplifying wave and absolute instability, interaction in a one dimensional system (Longitudinal and Transverse interaction), interaction with cold. plasma in systems of finite transverse dimensions.

Title: EEE 6708
Course Name: Antenna Array Signal Processing.

Credit: 3 Contact Hours/week: 3

Introduction: Antenna Gain. Phased Array Antenna. Power Pattern. Beam Steering, Degree of Freedom. Optimal Antenna, Adaptive Antenna, Smart Antenna. Narrowband Processing: Signal Model, Steering Vector Representation, Eigenvalue Decomposition, Conventional, Deamformer, Source in Look Direction, Directional Interference, Random Noise Environment, Signal-to-Nise Ratio, Null Steering Beamformer, Optimal Beamformer, Unconstrained Beamformer, Constrained Beamformer, Output Signal-to-Noise Ratio and Array Gain, Beam Space Processing, Optimal Beam Space Processor, Postbeamformer Interference Canceller,

Optimal PIC, PIC with Conventional Interference Beamformer, PIC with Orthogonal Interference Beamformer, PIC with Orthogonal Interference Beamformer, PIC with Improved Interference Beamformer, Comparison of Post Beamformer Interference Canceller with Element Space Processor, Adaptive Processing: Sample Matrix Inversion Algorithm, Unconstrained Least Mean Squares Algorithm, Recursive Least Mean Squares Algorithm, Real LMS Algorithm, Robust Beamforming: Comparison in Presence of Look Direction Errors, Effect of Errors, Weight Vector Errors, Steering Vector Errors, Phase Shifter Errors, Effect of Mutual Coupling.

Course Title: EEE 6709
Course Name: Broadband Beamforming Processors

Credit: 3 Contact Hours/week: 3

Course Content:
Topped-Delay Line Structure, Frequency Response, Optimization. Minium Mean Square Error Design, Derivation of Constraints, Optimization. Partitioned Realization: Generalized Side-Lobe Conceller, Constrained Partitioned Realization, General Constrained Partitioned Realization, Correlation Constrained Processor, Digital Beamforming, Frequency Domain Processing, Relationship with Tanned- Delay Line Structure Processing: Weight Relationship, Matrix Relationship, Derivation of Rf (k), Array with Presteering Delays, Array without Prestering Delays, Broadband Processing Using Discrete Fourier Transform Method: Weight Estimation, Performance Comparison, Effect of Filter Length, Effect of Number of Elements in Array, Effect of Interference Power, Computational Requirement Comparison, Direction-of-Arrary Estimation_Methods. Convolution Constrained Methods in Broadband Beamforming, Robust Broadband Beamforming.

Course Title: EEE 6710
Course Name: Bioelectromagnetics

Credit: 3 Contact Hours/week: 3

Course Content:
Electric, magnetic and dielectric properties of biological materials and the problems of coupling electric and magnetic fields into biological materials, effects of electric and magnetic fields on biological materials at low frequencies, RF as well as microwave frequencies, computational methods for predicting field intensities of biological materials, discussion of possible health effects of electric and magnetic fields during EM imaging and experimental EMF exposure assessment.

Course Title: EEE 6711
Course Name: Advanced Microwave Circuit Design
Credit: 3 Contact Hours/week: 3

Course Content:
EM field principles followed by network theory for analysis and design of microwave circuits. Planar guiding structures and hybrid and/monolithic integration of passive and active microwave devices. Concept of noise and nonlinearities followed by the equivalent circuit models of diodes and transistors to generate switch, phase shift, detect, mix or amplify microwave signals.

Modern microwave CAD software packages for simulation and optimization of microwave passive and active components and sub-systems.

Course Title: EEE 6712
Course Name: Relativistic Electron Beam Technology
Credit: 3 Contact Hours/week: 3

Course Content:
Introduction to REB; Generation of REB; Propagation of REB. Theory of particle acceleration in liner accelerator. Special theory of Relativity; Dynamics of relativistic particles and electromagnetic fields.

Course Title: EEE 6713
Course Name: Fusion Science and Technology
Credit: 3 Contact Hours/week: 3

Course Content:
Introduction to Nuclear Fusion; Fusion reaction and fuel resources; Plasma confinement, Tokamak confinement physics; Thermonuclear devices based on pinch effect; Mirror like devices. Fusion technology; Plasma heating; Introduction to a commercial Tokamak Fusion Power Plant.

Course Title: EEE 6714
Course Name: Electromagnetic Metamaterial
Credit: 3 Contact Hours/week: 3

Course Content:
Introduction to metamaterials, Negative index metamaterials, Electromagnetic response of metamaterials, Dispersion profile of natural materials and metamaterials, Refraction in natural materials and metamaterials, Hyperbolic metamaterials and their applications, Diffraction and their origin, Metamaterial based imaging devices: Superlens and Hyperlens, Metamaterial design, modeling and fabrication.

Course Title: EEE 6715
Course Name: Microwave Photonics

Credit: 3 Contact Hours/week: 3

Course Content:

Review of Microwave & Photonic devices:

Photonics: Semiconductor lasers (Basics, Modulation, Noise), Optical amplifiers, High speed photo-detection (Basics, Noise, PIN, traveling wave and Uni- traveling carrier photodiodes), High speed optical modulators (Mach-Zehnder, Electro-absorption, Microdisk/microring), Optical filters.

Microwave: Transmission lines, Resonators and Filters, Amplifiers and Mixers.

Applications of Microwave Photonics:

Photonic microwave links, radio over fiber links and its application, Photonic generation and processing of microwave, mm-wave and THz signals, Photonic phased array antennas, Optoelectronic microwave oscillator, optical frequency comb generator, Photonic analog-to-digital conversion, photonic down conversion, optoelectronic oscillators for sensing and measurement, MWP in satellite communication, Radar and Lidar systems.

Integrated Microwave Photonics:

Materials and Platforms for integrated MWPs, Silicon Photonics (main components, design principles), selected silicon based MWP systems, multi-project wafer based integrated photonics.

Course Title: EEE 6801
Course Name: Architecture of Microprocessors and Microcomputers

Credit: 3 Contact Hours/week: 3

Course Content:

Internal organization of the Intel 8085, M6800, Z80, M6809, Rockwell 6502, Intel 8086/88, M6800 and Z8000 Microprocessors. Comparison of the architectures based on hardware feature such as addressing modes interrupt structures, instruction execution, multiprogramming abilities and memory management.

Bit-Slice processors: Basic structure of control unit of a microprocessor. Organization of bit slice processors like AM2903 and Intel 3008 Comparison with microprocessor chips.

Architecture of microcomputers like SDK- 85, HP 5032, SDK- 86, single chip microcomputer 8748, intelligent CRT terminal, microprocessor development system like Intellect series II and III, BBC- microcontrollers PLCS, graphics processors and floppy disk controllers; arithmetic processors like Intel 8087 and 80287; EET processors and arry processors.

Course Title: EEE 6802

Course Name: Design and Organization of Microcomputer

Credit: 3 Contact Hours/week: 3

Course Content:

Number system: Floating point arithmetic. Organization of a small computer control unit and I/O structures. Various aspects of machine language, Assembly language and assemblers. Typical programmable and non programmable peripheral support LSI. Single chip microprocessor. Microprocessor based signal processing and control instrumentation. Microprocessor based system design.

Course Title: EEE 6803

Course Name: Computer Simulation Electrical & Electronic Circuits

Credit: 3 Contact Hours/week: 3

Course Content:

DC analysis of liner network; solution of simultaneous, sparse, linear equations; DC analysis of nonlinear circuits, transient analysis of linear and nonlinear circuits, hybrid analysis. Circuit models for common semiconductor devices like BJT, MOSFET, thyristor. Macromodels for analog ICs like the opamp. Implementation of a general purpose circuit. analysis program like SPICE.

Course Title: EEE 6804

Course Name: Computer in Electrical Engineering

Credit: 3 Contact Hours/week: 3

Course Content:

Prerequisite: Students will be required to have a general knowledge about microcomputers and database and spread sheet programs. They are also required to have a fair knowledge of programming in either C or Pascal. Use of microcomputers in different fields of electrical engineering for design, simulation, analysis etc. Demonstration program development in one of the above fields.

Course Title: EEE 6805

Course Name: Computer aided Instrumentation and Sensor Application

Credit: 3 Contact Hours/week: 3

Course Content:

Review of different types of sensors and their operation characteristics, Signal conditioning and driver circuits, ADC and DAC applications, Signal multiplexing, interfacing techniques interfacing external circuit with pc, serial and parallel port, port programming, reading data from outside pc, sending data to port, open loop and closed loop instrumentation. Practical examples dealing with linear and angular displacement, force, light, temperature and acoustic signals. Introduction

to different types of standard interfacing bus such as GPIB, HPIB IEEE488 etc.

Course Title: EEE 6806
Course Name: Computer aided Optoelectronics Application
Credit: 3 Contact Hours/week: 3

Course Content:
Elements of optoelectronics, Light and laser Light, Laser system. Photo detectors, Radiometry and light coupling systems and applications, fiber optic telephone link, optical imaging using CCD cameras, Laser scanning camera, interfacing camera with pc.

Course Title: EEE 6807
Course Name: Computer aided Simulation of Physical Systems
Credit: 3 Contact Hours/week: 3

Course Content:
Basic concept of simulation, system modeling simulation of continuous and time discrete system, queuing simulation, pert network, simulation software, simulation examples of some real life physical systems of different types.

Course Title: EEE 6808
Course Name: Introduction to Machine Learning
Credit: 3 Contact Hours/week: 3

Course Content:
Linear Regression, Logistic Regression, Probability for Machine Learning, Optimization for Machine Learning, Linear Classification, Nonparametric Methods, Decision Trees, k-Nearest Neighbour, Multi-class Classification, Probabilistic Classifiers I, Naive Bayes and Gaussian Bayes Classifier, Probabilistic Classifiers II, Neural Networks I, Neural Networks II, Clustering, Kernels and Margins, Support Vector Machines.

Course Title: EEE 6809
Course Name: Statistical Machine Learning
Credit: 3 Contact Hours/week: 3

Course Content:
Statistical Theory: Maximum likelihood, Bayes, minimax, parametric versus nonparametric methods, Bayesian versus Non-Bayesian approaches, classification, regression, density estimation.

Convexity and Optimization: Convexity, conjugate functions, unconstrained and constrained optimization, KKT conditions.

Parametric Methods: Linear regression, model selection, generalized linear models, mixture models, classification, graphical models, structured prediction, hidden Markov models

Sparsity: High dimensional data and the role of sparsity, basis pursuit and the lasso revisited, sparsistency, consistency, persistency, greedy algorithms for sparse linear regression, sparsity in nonparametric regression. sparsity in graphical models, compressed sensing

Nonparametric Methods: Nonparametric regression and density estimation, nonparametric classification, clustering and dimension reduction, manifold methods, spectral methods, the bootstrap and subsampling, nonparametric Bayes.

Advanced Theory: Concentration of measure, covering numbers, learning theory, risk minimization, Tsybakov noise conditions, minimax rates for classification and regression, surrogate loss functions.

Kernel Methods: Mercel kernels, kernel classification, kernel PCA, kernel tests of independence.

Computation: The EM Algorithm, simulation, variational methods, regularization path algorithms, graph algorithms

Deep Learning Methods: Multilayer neural network, Convolutional neural network, Autoencoder and reinforcement learning.

Course Title: EEE 6810
Course Name: Wearable Signal Processing and Machine Learning in Healthcare

Credit: 3 Contact Hours/week: 3

Course Content:
Signal processing techniques for wearable sensors:

Classical and Adaptive filtering Bayesian Filtering: Wiener, Recursive Wiener, Kalman, Extended or unscented Kalman, Particle Filtering.

Blind Source Separation: Principal component analysis, Independent component analysis, Singular value decomposition.

Spectro-temporal Analysis: Wavelet transform, Short time Fourier transform/ complex wavelet transform/Dual tree complex wavelet transform.

Non-linear Data Driven Empirical Techniques: Hilbert Huang transformation, Empirical mode decomposition, Ensemble empirical mode decomposition, Variational mode decomposition.

Machine learning techniques for wearable sensors: Support vector machines, decision tree, random forest.

Deep learning techniques for wearable sensors: Multilayer neural network, Convolutional neural network, Autoencoder and reinforcement learning.

Course Title: EEE 6901
Course Name: Behavior of Dielectrics Under High Voltage
Credit: 3 Contact Hours/week: 3

Classification of Electric Field, Schwaiger factor, Numerical estimation of Electric Fields. Charge Simulation Method. reakdown mechanism: Development of Avalanches Streamer and Leader Process, arcs. Intrinsic and practical strength of dielectrics. Time required for inception of breakdown channel. Breakdown and aging in solid dielectrics; Treeing process.

Insulation properties of vacuum and gases other than air. Gas insulated systems.

Course Title: EEE 6902
Course Name: Insulators for High Voltage
Credit: 3 Contact Hours/week: 3

Course Content:
Introduction, functions of insulators, classification, insulation materials, manufacturing processes of different insulators, terminal fitting of insulators, insulator life, contamination, testing of insulators, remedies of flashover, insulators for special application, hot-sticks.

Course Title: EEE 6903
Course Name: High Voltage Power Equipment Engineering
Credit: 3 Contact Hours/week: 3

Course Content:
Basic Concept of circuit interruption, Impulse characteristics and corona, Lightning, traveling wave propagation, lightning protective devices, design of lightning proof transmission lines, grounding, Insulation co-ordination.

Course Title: EEE 6904

Course Name: Insulating Properties of Vacuum under High Voltage

Credit: 3 Contact Hours/week: 3

Course Content:

Review of breakdown mechanism in air uniform and non uniform field, micro discharges, factors affecting breakdown in vacuum, electrode gap, electrode materials, surface contamination, area effect, temperature effect, type of applied voltage, breakdown under dc, ac impulse voltage, frequency of applied voltage, Effect of pressure, recovery of insulation property after breakdown, flash over across solid used in vacuum, Remedies.

Course Title: EEE 6905

Course Name: Insulating Properties of SF_6, under High Voltage

Credit: 3 Contact Hours/week: 3

Course Content:

General properties of SF_6, review of breakdown mechanism in gas, breakdown mechanism in SF_6, arc interruption, current chopping in SF_6, mixture of SF_6 with other gases, SF, insulated equipments. SF circuit breakers, SF_6 insulated underground cables, SF_6 insulated substations, SF_6 gas filling and handling plants, Insulation co-ordination in SF_6 insulated substations, Future trends.

Course Title: EEE 6906

Course Name: HVDC Power Transmission

Credit: 3 Contact Hours/week: 3

Course Content:

DC power transmission technology, HVDC converters system control, faults and protection, smoothing reactors, reactive power control, multi terminal dc system, analysis of ac/dc dynamic simulation of converters and dc systems.