Syllabus
BSc Engineering

Session 2019-2020 and onwards

Department of Electrical and Electronic Engineering
University of Dhaka
Dhaka, Bangladesh

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Department of Electrical and Electronic Engineering
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Department of Electrical and Electronic Engineering (EEE)
University of Dhaka

About the Department

Department of Electrical and Electronic Engineering (EEE) is one of the largest engineering departments under the Faculty of Engineering and Technology, University of Dhaka, Bangladesh. The Department of EEE, started its journey as the Department of Applied Physics in September 1965, offering MSc degree. Professor Shah Md. Fazlur Rahman was the founding chairman of the department. In 1974, the department was renamed as Applied Physics and Electronics with an updated MSc curriculum that catered to the needs of the electronics job market. The following year, in 1975, BSc program in Applied Physics and Electronics was started. To keep up with the demands of the telecommunication sector, the department was renamed as Applied Physics, Electronics and Communication Engineering in October 2005. Applied Physics, Electronics and Communication Engineering department became a part of the Faculty of Engineering and Technology in June 2008. Finally, in November 2014, the department emerged in its current state as the Department of Electrical and Electronic Engineering.

Degrees Offered:

BSc Engg. : 4 years (eight semesters) undergraduate program
MSc Engg. : 1.5 year (three semesters) postgraduate program
PhD : 4 years in any related field

Research Areas:

The research areas are divided into four streams:

1) **Power:** This includes but not limited to, Power Electronics, Power Generation, Transmission, Distribution, Fault Detection, Protection, Photovoltaic Systems, and Renewable Energy.
2) **Electronics:** This includes but not limited to, Analog and Digital Electronics, VLSI Circuit Design, Electronic and Optoelectronic Devices, Photonics, Nanoscience and Technology, Materials Science, Biomedical Engineering.
3) **Communications and Signal Processing:** This includes but not limited to, Telecommunication Engineering, Mobile Cellular Technology, 3G, 4G, 5G Wireless Networks, Satellite and Radar Communication, Signal Processing, Optical Fiber Communication.
4) **Computer:** This includes but not limited to, Algorithm Design, Artificial Intelligence, Robotics, Computer Architecture, IoT, Microcontroller-Based Systems, Micro-Processor, Big Data Analytics.

Laboratories:

1) **Power:** Power Protection Lab, Power Systems Lab, Machine Lab, Power Electronics Lab.
2) **Electronics:** Electrical and Electronic Circuit Lab, Analog Electronics Lab, Digital Electronics Lab, VLSI Design Lab.
3) **Communications and Signal Processing:** Communication Lab, Digital Signal Processing Lab, Microwave and Optical Fiber Communication Lab.
4) **Computer:** Computer Programming Lab, Microprocessor and Interfacing Lab, Data and Computer Network Lab, Control System Lab.
5) **Others:** Physics Lab, Optics Lab, Mechanical Engineering Lab, Chemistry Lab.

Career Opportunities in Bangladesh:

1) **Power:** Power Grid Company of Bangladesh (PGCB), Dhaka Electric Supply Authority (DESA), Dhaka Electric Supply Company Limited (DESCO), BCS Professional Cadre.
2) **Electronics:** VLSI Design Companies, Bangladesh Atomic Energy Commission (BAEC), Bangladesh Council of Scientific and Industrial Research (BCSIR), Hospitals and Clinics (as a Biomedical Engineer), Nuclear Power Plant.
3) **Communications and Signal Processing:** Radio and Television Channel Companies, Space Research and Remote Sensing Organization (SPARSO), BCS Professional Cadre, Mobile Phone Companies.
4) **Computer:** Software Companies, Samsung R&D, Internet and Network Service Providers.

Career Opportunities Abroad:

Graduates from this department are successfully working at different renowned companies worldwide, after completing their higher studies abroad, such as Intel (USA), IBM (USA), Globalfoundries (USA), Samsung (South Korea), Huawei (China), Hewlett Packard (USA), Micron (USA), IM-Flash (USA), Synopsys (USA), ASML (Netherlands), Schneider (France), Amazon Lab (USA), Teaching and research positions in foreign Universities.

Higher Study Prospects:

Students graduated from this department can pursue higher studies and research at home and abroad in any related field. After graduation, students can apply for Full-Bright Scholarship, Commonwealth Scholarship, Monbukagakusho Scholarship, DAAD Scholarship, AUSAID Scholarship, Erasmus Mundus Scholarship. In addition, lot of research and teaching assistantship opportunities are available worldwide.

The Framework of the Semester System:

Program: BSc Engg. in EEE

1. **Admission:** Students will be admitted to the department as per university rules.
2. **Duration of the Program:** 4 years
3. **Total Number of Semesters:** 4 × 2 = 8 (2 Semesters per year)

Class:	14 weeks
Preparatory Leave (PL):	02 weeks
Final Examination:	03 weeks
Results:	03 weeks
Total:	22 weeks per semester

4. **Total Credits in 8 Semesters (4 years): 165**

Course Identification:

Every course has a unique course code. The letter prefix in any course code indicates the field or the discipline of the course, e.g., **EEE** stands for **Electrical and Electronic Engineering**, **CSE** for C**omputer Science and Engineering**, **IPE** for **Industrial and Production Engineering**, **MEC** for **Mechanical Engineering**, **CHE** for **Chemistry**, **PHY** for **Physics**, **MAT** for **Mathematics, STA** for **Statistics** and **GED** for **General Education**.

The digits in the course code have the following meaning:

- The first digit corresponds to the year in which the course is offered by the department.
- The second digit represents the semester in which the course is offered by the department.
- The third and fourth digits are used to specify the course.
- The last digit is odd for theoretical course and even for laboratory or sessional course.

The third digit of the course number has the following meaning:

- 0, 1 for Core Courses (compulsory for all students)
- 3 for Electronics Stream
- 4 for Communications and Signal Processing Stream
- 5 for Power Stream
- 6 for Computer Stream
- 7 for Interdisciplinary Courses

Total credits to be completed for obtaining the degree of BSc Engg. in Electrical and Electronic Engineering is 165.

Classes/Contact Hours for the Courses:

a. For each credit of a theory course, there will be 1 class per week of 1 hour duration.

b. Total number of classes in a semester for each credit of a theory course will be 14 (14×1).

c. Total Contact Hours in a semester for each 1 credit theory course will be 14×1=14 hours.

d. For each 1 credit lab course, there will be 1 class per week of 2 hours duration.

e. Total classes in a semester for each 1.0 credit lab course in 14 weeks: 14×1=14.

f. Total Contact Hours in a semester for each 1.0 credit lab course: 14×2=28.

Evaluation of the Courses: As per university rules.

Grading System:

The current University Grants Commission (UGC) approved grading system applies as per university rules.

Marks	Letter Grade	Grade Point
80% and above	A+	4.00
75% to <80%	A	3.75
70% to < 75%	A-	3.50
65% to < 70%	B+	3.25
60% to < 65%	B	3.00
55% to < 60%	B-	2.75
50% to < 55%	C+	2.50
45% to < 50%	C	2.25
40% to < 45%	D	2.00
Less than 40%	F	0.00

Marks Distribution:

For a Theory Course:

i. Attendance	05%
ii. Assignment/Presentation	05%
iii. Mid-term Examination (Incourse)	20%
iv. Final Examination	70%
Total	**100%**

For a Laboratory Course:

i. Attendance	10%
ii. Continuous Assessment	40-90%
iii. Final	0-60%
Total	**100%**

Attendance:

Students with **75% attendance and above** in each course will be eligible to sit for the semester final examinations. Students having attendance **>=60% and <75%** will be considered to sit for the examination after paying the fines as per university rules. **Students having attendance below 60% will not be eligible to appear in the examination**. The marks distribution for attendance is given below:

Attendance	Marks
90% and above	5.0%
85% to < 90%	4.5%
80% to < 85%	4.0%
75% to < 80%	3.5%
70% to < 75%	3.0%
65% to < 70%	2.5%
60% to < 65%	2.0%
Less than 60%	0.0%

Promotion to the Next Academic Year:

The minimum CGPA required for promotion to the next year:
1st year to 2nd year : 2.00
2nd year to 3rd year : 2.25
3rd year to 4th year : 2.50

Requirements for the Award of the BSc Engg. Degree:

To achieve the BSc Engg. degree, the students must obtain CGPA of at least 2.50 out of 4.00 without F grade in any course.
The students must complete required credits within a maximum period of six academic years starting from their 1st year session.

Improvement Examination:

A student may sit for improvement examination for courses where grade obtained is less than or equal to C+ (C plus). However, the awarded grade will not be more than B+ (B plus) in any improvement examination. If the grade is not improved, the previous grade will remain valid.

Readmission and Dropout:

A student may be permitted for re-admission for a maximum of two times within six consecutive academic years. A student may seek permission for re-admission provided he/she had at least 30% of attendance in the previous semester or year.

Semester-Wise Course and Credit Distribution of Different Years:

Year	Courses (Credits)	
Year 1	**Semester I:** Theory Courses: 5 (3×5 Credits) Lab Courses: 2 (1.5×2 Credits) **Total: 18 Credits**	**Semester II:** Theory Courses: 5 (3×5 Credits) Lab Courses: 3 (1.5×2 Credits) **Total: 19.5 Credits**
Year 2	**Semester I:** Theory Courses: 6 (3×6 Credits) Lab Courses: 2 (1.5×2 Credits) **Total: 21 Credits**	**Semester II:** Theory Courses: 5 (3×5 Credits) Lab Courses: 3 (1.5×3 Credits) **Total: 19.5 Credits**
Year 3	**Semester I:** Theory Courses: 6 (3×6 Credits) Lab Courses: 2 (1.5×3 Credits) **Total: 21 Credits**	**Semester II:** Theory Courses: 6 (3×6 Credits) Lab Courses: 3 (1.5×3 Credits) **Total: 22.5 Credits**
Year 4	**Semester I:** Theory Courses: 5 (3×5 Credits) (Compulsory: 2+Stream: 2+Optional: 1) Lab Courses: 3 (1.5×3 Credits) (Compulsory: 1+Stream: 1+Optional: 1) Project: 1 (2 Credits) **Total: 21.5 Credits**	**Semester II:** Theory Courses: 5 (3×5 Credits) (Compulsory: 1+Stream: 2+Optional: 1 +Interdisciplinary: 1) Lab Courses: 2 (1.5×2 Credits) (Compulsory: 1+Interdisciplinary: 1) Project: 1 (4 Credits) **Total: 22 Credits**
	Grand Total: 165 Credits	

Optional Courses:

From 4th Year 1st Semester, Department of Electrical and Electronic Engineering will offer four streams which are - **Electronics**, **Communications and Signal Processing**, **Power**, and **Computer**. Students will choose their stream according to their interest and future plan. Number of streams offered finally may vary depending on the availability of faculties and the number of students enrolled. In addition to the courses of his/her stream, every student has to take two theory courses and one associated laboratory course from any other streams.

Syllabus for BSc Engg. in Electrical and Electronic Engineering
Semester-Wise Distribution of Courses and Credits of Different Years

First Year (Semester-I)

Course Code	Course Title	Credits
EEE 1101	Electrical Circuit Analysis	3
PHY 1101	Electricity and Magnetism	3
MAT 1101	Differential and Integral Calculus	3
MAT 1103	Linear Algebra and Numerical Analysis	3
GED 1101	English for Technical Communication	3
EEE 1102	Electrical Circuit Analysis Laboratory	1.5
EEE 1104	Computer Aided Engineering Drawing	1.5
	Total Credit in 1st Year 1st Semester	**18**

First Year (Semester-II)

Course Code	Course Title	Credits
CSE 1201	Computer Programming	3
PHY 1201	Modern Physics	3
PHY 1203	Optics	3
CHE 1201	Chemistry	3
MAT 1201	Vector Calculus and Complex Analysis	3
CSE 1202	Computer Programming Laboratory	1.5
PHY 1204	Physics Laboratory	1.5
CHE 1202	Chemistry Laboratory	1.5
	Total Credit in 1st Year 2nd Semester	**19.5**

Second Year (Semester-I)

Course Code	Course Title	Credits
EEE 2101	Analog Electronics I	3
EEE 2103	Digital Electronics	3
EEE 2105	Solid State Physics	3
EEE 2107	Electromechanical Energy Conversion I	3
EEE 2109	Signals and Systems	3
MAT 2101	Ordinary and Partial Differential Equations	3
EEE 2102	Circuit Simulation Laboratory	1.5
EEE 2104	Digital Electronics Laboratory	1.5
	Total Credit in 2nd Year 1st Semester	**21**

Second Year (Semester-II)

Course Code	Course Title	Credits
EEE 2201	Analog Electronics II	3
EEE 2203	Electromechanical Energy Conversion II	3
MEC 2201	Fundamentals of Mechanical Engineering	3
STA 2201	Probability and Statistics	3
GED 2201	Fundamentals of Economics	3
EEE 2202	Analog Electronics Laboratory	1.5
MEC 2202	Mechanical Engineering Laboratory	1.5
EEE 2204	Electromechanical Energy Conversion Laboratory	1.5
	Total Credit in 2nd Year 2nd Semester	**19.5**

Third Year (Semester-I)

Course Code	Course Title	Credits
EEE 3101	Electromagnetic Theory and Antenna	3
EEE 3103	Microprocessor and Interfacing	3
EEE 3105	Communication Systems	3
EEE 3107	Industrial and Medical Instrumentation	3
EEE 3109	Electronic Devices	3
IPE 3101	Industrial Management	3
EEE 3104	Microprocessor and Interfacing Laboratory	1.5
EEE 3106	Communication Systems Laboratory	1.5
	Total Credit in 3rd Year 1st Semester	**21**

Third Year (Semester-II)

Course Code	Course Title	Credits
EEE 3201	Power System I	3
EEE 3203	Digital Signal Processing	3
EEE 3205	Materials Science	3
EEE 3207	Optoelectronics and Photonics	3
EEE 3209	Communication Theory	3
GED 3201	Financial Accounting and Cost Management	3
EEE 3202	Power System I Laboratory	1.5
EEE 3204	Digital Signal Processing Laboratory	1.5
EEE 3212	Electrical Services Design and Drafting Laboratory	1.5
	Total Credit in 3rd Year 2nd Semester	**22.5**

Fourth Year (Semester-I)

Course Code	Course Title	Credits
Compulsory Courses		
EEE 4101	Power Electronics and Industrial Automation	3
*GED 4101	Professional Ethics	3
EEE 4102	Power Electronics and Industrial Automation Laboratory	1.5
EEE 4100	Project Work	2
Electronics Stream		
EEE 4131	Device Fabrication Techniques	3
EEE 4133	VLSI Circuit Design	3
EEE 4134	VLSI Design Laboratory	1.5
Communication Stream		
EEE 4141	Telecommunication Engineering	3
EEE 4143	Optical Fiber Communication Systems and Networks	3
EEE 4144	Optical Fiber Communication Laboratory	1.5
Power Stream		
EEE 4151	Power System II	3
EEE 4153	Power System Protection	3
EEE 4154	Power System Protection Laboratory	1.5
Computer Stream		
EEE 4161	Computer Organization and Architecture	3
EEE 4163	Data and Computer Network	3
EEE 4164	Data and Computer Network Laboratory	1.5
	Total Credit in 4th Year 1st Semester	**21.5**

*This course may replaced by GED 4103/GED 4105/ GED 4107

Fourth Year (Semester-II)

Course Code	Course Title	Credits
Compulsory Courses		
EEE 4201	Control Engineering	3
EEE 4271	Renewable Energy Technology	3
EEE 4202	Control Engineering Laboratory	1.5
EEE 4272	Renewable Energy Technology Laboratory	1.5
EEE 4200	Project Work	4
Electronics Stream		
EEE 4231	Quantum Mechanics	3
EEE 4233	Nanoelectronics	3
Communication Stream		
EEE 4241	Mobile Cellular Communication	3
EEE 4243	Microwave and Satellite Communication	3
Power Stream		
EEE 4251	Power System Operation and Control	3
EEE 4253	Power Plant Engineering	3
Computer Stream		
EEE 4261	Artificial Intelligence	3
EEE 4263	Data Base Management System	3
	Total Credit in 4th Year 2nd Semester	**22**

NB: Stream Courses may be changed if required, depending on the availability of faculties and demand.

GED Core Courses (4×3 =12 Credits)

Course Code	Course Title	Credits
GED 1101	English for Technical Communication	3
GED 2201	Fundamentals of Economics	3
GED 3201	Financial Accounting and Cost Management	3
*GED 4101/ GED 4103/ GED 4105/ GED 4107	*Professional Ethics/ Industrial Sociology/ Industrial Psychology/ Engineering Economics	3
	Total Credits	**12**

*One course will be offered depending on the availability of faculty.

Interdisciplinary Courses: (1 Compulsory Course and 1 Relevant Lab Course: 4.5 Credits)

Course Code	Course Title	Credits
EEE 4271	Renewable Energy Technology	3
EEE 4272	Renewable Energy Technology Laboratory	1.5
	Total Credits	**4.5**

CSE, Physics, Mathematics, Statistics, Chemistry, Mechanical Engineering, Industrial and Production Engineering as Compulsory Courses:

Course Code	Course Title	Credits
PHY 1101	Electricity and Magnetism	3
MAT 1101	Differential and Integral Calculus	3
MAT 1103	Linear Algebra and Numerical Analysis	3
CSE 1201	Computer Programming	3
PHY 1201	Modern Physics	3
PHY 1203	Optics	3
CHE 1201	Chemistry	3

MAT 1201	Vector Calculus and Complex Analysis	3
MAT 2101	Ordinary and Partial Differential Equations	3
STA 2201	Probability and Statistics	3
MEC 2201	Fundamentals of Mechanical Engineering	3
CSE 1202	Computer Programming Laboratory	1.5
PHY 1204	Physics Laboratory	1.5
CHE 1202	Chemistry Laboratory	1.5
MEC 2202	Mechanical Engineering Laboratory	1.5
IPE 3101	Industrial Management	3
	Total Credits	**42**

Optional Courses for Different Streams:

Electronics Stream:

Sl. No	Course Code	Course Title	Credits
1.	EEE 4131	Device Fabrication Techniques	3
2.	EEE 4133	VLSI Circuit Design	3
3.	EEE 4231	Quantum Mechanics	3
4.	EEE 4233	Nanoelectronics	3
5.	EEE 4x35	Advanced Semiconductor Devices	3

Communications and Signal ProcessingStream:

Sl. No	Course Code	Course Title	Credits
1.	EEE 4141	Telecommunication Engineering	3
2.	EEE 4143	Optical Fiber Communication	3
3.	EEE 4241	Mobile Cellular Communication	3

4.	EEE 4243	Radar and Satellite Communication	3
5.	EEE 4x45	Digital Image Processing	3
6.	CSE 4x47	Network and Information Security	3

Power Stream:

Sl. No	Course Code	Course Title	Credits
1.	EEE 4151	Power System II	3
2.	EEE 4153	Power System Protection	3
3.	EEE 4251	Power System Operation and Control	3
4.	EEE 4253	Power Plant Engineering	3
5.	EEE 4x55	High Voltage Engineering	3

Computer Stream:

Sl. No	Course Code	Course Title	Credits
1.	EEE 4161	Computer Organization and Architecture	3
2.	EEE 4163	Data and Computer Network	3
3.	EEE 4261	Artificial Intelligence	3
4.	EEE 4263	Data Base Management System	3
5.	CSE 4165	Big Data Analytics	3
6.	CSE 4167	Object Oriented Programming	3
7.	CSE 4265	Internet of Things	3
8.	CSE 4267	Neural Networks and Fuzzy Systems	3
9.	CSE 4269	Robotics and Embedded Systems	3

Detail Course Contents for BSc Engineering Program

1st Year 1st Semester

EEE 1101	Electrical Circuit Analysis	3 Credits, 3 Hours/Week

Basic Concepts of Electrical Circuits: Charge, Current, Voltage, Power, DC Voltage and DC Current Sources, Sinusoidal AC Voltage Characteristics and Definition, Phase Relation, Average Value, Effective (rms) Values, Different AC Waveforms- Square, Triangular, Rectangular and Sawtooth.

The Basic Electrical Circuit Elements: Response of Basic R, L, and C Elementsto DC and a Sinusoidal Voltage or Current, Admittance, Susceptance, Reactance and Impedance of R, L, and C Elements, Frequency Response of the Basic Elements, Average Power and Power Factor, Phasor.

Methods of Circuit Analysis (DC & AC): Ohm's Law, Nodes, Branches, Loops, Kirchhoff's Laws, Independent versus Dependent Sources, Source Conversions, Mesh Analysis, The Supermesh, Nodal Analysis, The Supernode, Delta-Wye Conversion.

Network Theorems (DC & AC): Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum Power Transfer Theorem, Millman's Theorem, Substitution Theorem, Reciprocity Theorem.

RC, RL and RLC Circuits: Source Free and Unit Step Transient Responses of RC and RL Circuits, RC and RL High-Pass, Low-Pass Filters, Band-pass and Band-Stop Filters, Source Free and Unit Step Transient Responses in RLC Circuit- different Damping Characteristics, Series and Parallel RLC Resonances.

AC Power and Polyphase Circuits: Instantaneous Power, Average Power, Effective Values of Current and Voltage, Apparent Power, Power Factor and Complex Power, Polyphase Systems, Single-Phase Three-Wire Systems, Three-Phase Y-Y Connection, The Delta Connection Power Measurement in Three-Phase Systems.

Non-Sinusoidal Circuit Analysis: Circuit with Non-Sinusoidal Excitations, Power and Power Factor of AC Circuits with Multiple Sources of Different Frequencies.

References:

1. Fundamentals of Electric Circuits, 5th Edition, Charles Alexander and Matthew Sadiku, McGraw-Hill Education.
2. Introductory Circuit Analysis, 13th Edition, Robert L. Boylestad, Pearson Education.
3. Engineering Circuit Analysis, 9th Edition, William H. Hayt and Jack Kemmerly, McGraw-Hill Education.
4. Electronics and Circuit Analysis Using MATLAB, 2nd Edition, John O. Attia, CRC Press.

PHY 1101	Electricity and Magnetism	3 Credits, 3 Hours/Week

Electric Charges and Fields: Electric Charge, Conservation of Charge, Quantization of Charge, Coulomb's Law, Energy of a System of Charges, Electrical Energy in a Crystal Lattice, The Electric Field, Charge Distributions, Flux, Gauss's Law, Field of a Spherical Charge Distribution, Field of a Line Charge, Field of an Infinite Flat Sheet of Charge.

Electric Potential: Electric Potential and Electric Potential Energy, Equipotential Surfaces, Calculating the Potential from the Field, Potential Due to a Charged Particle, Potential Due a Group of Charged Particles, Potential Due to an Electric Dipole, Potential Due to a Continuous Charge Distribution, Calculating the Field from the Potential, Electric Potential Energy of a System of Charged Particles.

Electric Fields Around the Conductors: Conductors in the Electrostatic Field, The General Electrostatic Problem and the Uniqueness Theorem, Image Charges, Capacitance and Capacitors, Calculating the Capacitance, Capacitors in Parallel and Series, Energy Stored in an Electric Field, Capacitor with Dielectrics and Gauss's Law.

Magnetic Fields: What Produces a Magnetic Field, Vector potential, Crossed Fields: Discovery of the Electron, Crossed Fields: The Hall Effect, A Circulating Charged, Cyclotrons and Synchrotrons, Magnetic Force on a Current-Carrying Wire, Torque on a Current Loop, The Magnetic Dipole Moment.

Magnetic Fields Due to Currents: Calculating the Magnetic Field Due to a Current, Force between Two Parallel Currents, Biot-Savart Law, Ampere's Law, Solenoids and Toroids, Magnetic Dipole.

Electromagnetic Induction: Induction and Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductance, Self-Induction, Energy Stored in a Magnetic Field, Energy Density of a Magnetic Field, Mutual Induction.

References:

1. Electricity and Magnetism, 3rd Edition, Edward M. Purcell and David J. Morin, Cambridge University Press.
2. Fundamentals of Physics, Volume 2, 10th Edition, David Halliday, Robert Resnick and Jearl Walker, Wiley.
3. University Physics with Modern Physics, 15th Edition, Hugh D. Young and Roger A. Freedman, Pearson.
4. Fundamentals of Physics II, R. Shankar, Yale University Press.
5. Physics for Scientists and Engineers, 9th Edition, Raymond A. Serway and John W. Jewett, Cengage Learning.
6. Physics for Scientists & Engineers with Modern Physics, 4th Edition, Douglas C. Giancoli, Pearson.

MAT 1101	Differential and Integral Calculus	3 Credits, 3 Hours/Week

Functions, Limits and Continuity: Concept of Function, domain, Co-domain, range, One-one and Onto Functions, Finding the Inverse of a Function, Odd and Even Symmetric Functions, Polynomial, Algebraic and Transcendental Functions, The Existence of Limits, Asymptotic Behaviour of Function at Different Indeterminate Limits, Concepts of Continuity for Different Types of Functions.

Ordinary Differential Calculus: Local Linear Approximation, Differentials, L'Hôpital's Rule, Indeterminate Forms, Successive Differentiation of Single Variable and Leibnitz Theorem.

Partial Differential Calculus: Functions of Two or More Variables, Partial Derivatives, Higher Order Partial Derivatives, Theorems on Differentials, Differentiation of Composite Functions, Euler's Theorem on Homogeneous Function, Implicit Functions, Jacobians, Partial Derivatives using Jacobians.

Infinite Series: Test of Convergence, Taylor's and Maclaurin's Expansion of Functions of a Single Variable.

Applications of Differential Calculus: Extrema of Functions, Increase, Decrease, and Concavity of Function, Rational Functions, Cusps, and Vertical Tangents.

Integral Calculus: Differentiation under the Integral Sign, Leibnitz Rule.

Multiple Integral: Evaluation of Double and Triple Integrals, Transformations of Multiple Integrals, Differential Elements of Area and Volume in Cylindrical and Spherical Coordinates.

Improper Integrals and Special Function: Improper Integrals of Different Kinds, Fourier Integral, Gamma and Beta Functions, Dirichlet Integrals, Stirlings Approximations, Bessel Function.

References:

1. Calculus, 11th Edition, Howard Anton, Irl C. Bivens, Stephen Davis, Wiley.
2. Calculus, 5th Edition, Earl W. Swokowski, Cengage Learning.
3. Schaum's Outlines of Advanced Calculus, 3rd Edition, Robert C Wrede and Murray R Spiegel, McGraw-Hill Education.
4. Calculus, 3rd Edition, Gilbert Strang, Wellesley-Cambridge Press.
5. Schaum's Outline of Calculus, 6th Edition, Ayres Jr., Frank and, Elliott Mendelson, McGraw-Hill Education.
6. Schaum's 3, 000 Solved Problems in Calculus, 1st Edition, Elliott Mendelson, McGraw-Hill Education.

MAT 1103	Linear Algebra and Numerical Analysis	3 Credits, 3 Hours/Week

Linear Algebra

Systems of Linear Equations, Matrices and Determinants: Introduction to Systems of Linear Equations, Gaussian Elimination, Gauss-Jordan Elimination, Matrices and Matrix Operations, Methods of Finding Inverse of Matrix, Diagonal, Triangular, and Symmetric Matrices, Determinants by Cofactor Expansion, Evaluating Determinants by Row Reduction, Properties of Determinants, Cramer's Rule.

Vector Space and Subspaces: Vector in Different Dimensions, Concept of Subspace, Norm, Dot Product, and Distance, Orthogonality, Linear Independence Coordinates and Basis, Row Space, Column Space, and Null Space, Rank, Nullity, and the Fundamental Matrix Spaces.

Eigenvalues, Eigenvectors and Matrix Diagonalization: Eigenvalues and Eigenvectors, Matrix Diagonalization, Orthogonal Matrices, Orthogonal Matrix Diagonalization, Hermitian, Unitary, and Normal Matrices.

Matrix Decomposition: Gram–Schmidt Process, QR-Decomposition and Basic Concept of Singular Value Decomposition.

Numerical Analysis

Solutions of Equations in One Variable: The Bisection Method, Fixed-Point Iteration, Newton's Method and its Extensions and the Concept of Convergence.

Interpolation and Polynomial Approximation: Interpolation and the Lagrange Polynomial, Divided Difference Methods, Hermite Interpolation, Cubic Spline Interpolation.

Numerical Differentiation and Integration: Numerical Differentiation using Forward and Backward Difference Formula, The Trapezoidal Rule, Simpson's Rule, Romberg Integration.

Numerical Techniques to Differential Equations: Euler's Method, Runge-Kutta Methods, Finite Difference Method.

References:

1. Elementary Linear Algebra, 11th Edition, Howard Anton, Chris Rores, Wiley.
2. Introduction to Linear Algebra, 5th Edition, Gilbert Strang, Wellesley - Cambridge Press.
3. Linear Algebra, Elizabeth S. Meckes, Mark W. Meckes, Cambridge University Press.
4. Numerical Analysis, 10th Edition, Richard L. Burden, J. Douglas Faires, Annette M. Burden, Cengage Learning.
5. An Introduction to Numerical Analysis, Endre Süli, Cambridge University Press.

GED 1101	English for Technical Communication	3 Credits, 3 Hours/Week

Introduction: Global Position of English as a Language, Necessity of Learning a Second Language, English as a Language of Science and Technology Communication.

Grammar: Tense, Preposition, Subject Verb Agreement, Construction of Sentences, Transformation of Sentences: Active and Passive Transformation. Reported Speech, Grammatical Error, Conditionals.

Rhetoric: Introduction to Rhetoric, Rhetoric for Technical Communication and Persuasive Writing.

Developing Writing Skills: Principles of Effective Writing, Pre-Writing and Writing Process.

Paragraph Writing: Linking Sentences to Form a Paragraph, Paragraph Structure, Paragraph Unity and Coherence, Classification of Paragraphs.

Composition Writing: Short Composition.

Letter and E-Mail Writing: Formal and Informal, Precis Writing, Following Netiquette in E-mail Writing.

Report Writing: Defining a Report, Classification of Reports, Structure of a Report and Writing Reports.

Developing Reading Skills: Strategies of Reading: Skimming, Scanning, Inferencing, Analyzing and Interpreting Variety of Texts and Text Types.

Vocabulary Building and Phonetics: Correct and Precise Diction, Idiomatic Expressions**.**

English Phonetics: Vowels, Consonants and Diphthongs, Phonetic Transcription.

Developing Listening Skills: Practicing Listening by using Audio Visual Aids.

Developing Speaking Skills: Practicing Situational Dialogues; Role Play, Narrating Stories Debates, Interview Sessions, Extempore Speech, Effective Oral Presentation.

References:

1. A Practical English Grammar, A. J. Thomson and A. V. Martinet, Oxford University Press.
2. Effective reading, G. Simon and M. Swan, Cambridge University Press.
3. Most Common mistakes in English Usage, T. J. Berry, McGraw-Hill.
4. Practicing Faster Reading, G. Mosback and V. Mosback, McGraw-Hill.
5. From Paragraph to Essay, M. Imhoof, H. Hudson, Harlow Longman.
6. Commercial Correspondence and Report Writing, R. C. Sharma and Mohan Krishna, Tata-McGraw-Hill.

EEE 1102	**Electrical Circuit Analysis Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory Based on **EEE 1101**

EEE 1104	**Computer Aided Engineering Drawing**	**1.5 Credits, 3 Hours/Week**

1st Year 2nd Semester

CSE 1201	**Computer Programming**	**3 Credits, 3 Hours/Week**

Data Structure and Algorithm: Data Representations, Data Types and Data Structures, Abstract Data Types, Arrays, Linked-Lists, Stacks, Queues, Priority Queues, Trees, Graphs and their Related Algorithms, Different Types of Search and Sorting Algorithms, Algorithm Performance- Time-Space Complexity.

Programming in C: Overview of C, Constants, Variables and Data Types, Operators and Expressions, Input and Output Functions, Decision Making and Branching Structures- if, else-if, switch, goto, etc., The Loop Control Structures - For-Loop, Do-While Loop and While Loop, User Defined Functions, Recursion and Iterations, Arrays and 2D Array, Structures and Unions, Pointers, Searching, Sorting Techniques, Linked List using C, File Management using C- Creating, Reading Writing and Appending, File Related Different Functions.

Object Oriented Programming (OOP) using C++: Introduction, Importance of OOP, Classes and Objects, Polymorphism, Function and Operator Overloading, Inheritance.

References:

1. Data Structures with C, Seymour Lipschutz, McGraw-Hill Education.
2. C: The Complete Reference, 4th Edition, Herbert Schildt, McGraw-Hill Education.
3. Teach Yourself C, 3rd Edition, Herbert Schildt, McGraw-Hill
4. Programming in ANSI C, 7th Edition, E. Balagurusamy, McGraw-Hill.

PHY 1201	**Modern Physics**	**3 Credits, 3 Hours/Week**

The Special Theory of Relativity: Galilean and Newtonian Relativity, The Michelson-Morley Experiment, Einstein's Postulates, Consequences of Einstein's

Postulates, The Lorentz Transformation, Time Dilation, Length Contraction, The Velocity Transformation Law, Relativistic Energy -Momentum Relations, Relativity of Simultaneity and Relativistic Dynamics in Four Vector Notation.

The Particle like Properties Wave: Electromagnetic Waves, Black-body Radiation, Photoelectric Effect, Nature of Light, Photon, X-ray, X-ray Diffraction, Compton Effect, Photon and Gravity.

The Wavelike Properties of Particles: de Broglie's Hypothesis, Matter Wave, How Matter Wave is Described, The Motion of a Wave Packet, Group and Phase Velocity, Particle Diffraction, Particle in a Box, Uncertainty Relationships for Classical Waves, Heisenberg's Uncertainty Principles and its Applications.

Atomic Structure: The Nuclear Atom, Electron Orbits, Atomic Spectra, The Bohr Atom, Energy Levels and Spectra, Correspondence Principle, Nuclear Motion and Atomic Spectra.

Quantum Mechanics: Classical Mechanics as an Approximation to Quantum Mechanics, The Wave Equation, Time Dependent Schrodinger Equation, Time Independent Schrodinger Equation, Operator and Expectation Value, Particle in a Box, Particle in a Finite Potential Well and Tunnelling Effect.

References:

1. Concepts of Modern Physics, 6th Edition, Arthur Beiser, McGraw-Hill.
2. Modern Physics from α to Z, James William Rohlf, John Wiley & Sons.
3. Modern Physics, 3rd Edition, Kenneth S. Krane, John Wiley & Sons, INC.
4. Fundamentals of Physics I and II, R. Shankar, Yale University Press.

PHY 1203	**Optics**	**3 Credits, 3 Hours/Week**

Wave Motion: One-Dimensional Waves, Harmonic Waves, Complex Representation of Waves, The Superposition Principle, Phasors and the Addition of Waves, Plane Waves, Spherical Waves and Cylindrical Waves.

The Nature and Propagation of Light: Electromagnetic Waves, Energy and Momentum in EM Wave, Rayleigh Scattering, Reflection, Refraction, Fermat's Principle and Total Internal Reflection.

Geometrical Optics: Lenses, Stops, Mirrors, Prisms, Analytical Ray Tracing, Monochromatic Aberration, Spherical Aberration.

Polarization: The Nature of Polarized Light-Linear, Circular and Elliptical Polarization, Polarizers, Malus's Law, Dichroism and Dichroic Crystal, Polaroid, Birefringence, Polarization by Reflection and Scattering, Circular Polarizers, Optical Activity and Optical Modulators.

Interference: Principle of Superposition, Conditions for Interference, The Wavefront and Amplitude Splitting Interferometry, The Michelson Interferometer, The Mach–Zehnder Interferometer and Newton's Ring Experiment.

Diffraction: The Huygens–Fresnel Principle, The Difference between Fraunhofer and Fresnel Diffraction, Single and Double Slit Fraunhofer Diffraction, How Diffraction Limits Resolution in Imaging System and Diffraction Grating.

Introduction to Optical Fiber: Optical Fiber Structure, Numerical Aperture, Types of Optical Fiber: Step Index and Graded Index Fiber, The Coherent Bundle, Attenuation in Optical Fiber, Pulse Dispersion in Optical Fiber and Loss Mechanisms in Optical Fiber.

References:

1. Optics, 5th Edition, Eugene Hecht, Pearson Education Limited.
2. Optics, 1st Edition, Ajoy Ghatak, McGraw-Hill.
3. Fundamentals of Optics, 4th Edition, Francis Arthur Jenkins and Harvey Elliott White.
4. An Introduction to Fiber Optics, Ajoy Ghatak and K. Thyagarajan, Cambridge University Press.

CHE 1201	Chemistry	3 Credits, 3 Hours/Week

Structure of the Atom: Atom, Atomic Masses, Atomic Nucleus, Nuclear Binding Energy, Nuclear Stability, The Periodic Table, Elements and Compounds, Chemical Formulas.

Evolution of Atomic Theory: Thomson and Rutherford Model, Bohr Model of Hydrogen, Bohr-Sommerfeld Model and Multi-electron Atoms, Atomic Spectra, Schrödinger Equation, Electron Orbitals, Aufbau Principle, Pauli Exclusion Principle, and Hund's Rules.

Bonding and Molecules: Primary Bonding: Ionic, Covalent, Metallic. Secondary Bonding: Dipole-dipole, Induced Dipole-Induced Dipole, London Dispersion/van der Waals and Hydrogen Bond.

Shapes of Molecules: Hybridization, LCAO-MO, VSEPR Theory.

Reactions and Kinetics: Reaction Kinetics, Rate Laws, Thermal Activation, and the Arrhenius Equation. Diffusion: Fick's First and Second laws, Homogeneous and Heterogeneous Catalysis.

Phase Transformation and Mixture: Phase Diagram, Thermodynamics of Phase Diagram, Thermodynamics Description of Mixture, Phase Diagram of Binary System.

Redox Reactions: Charge and Electronic Concept, Oxidizing and Reducing Agents, Redox Half Reactions, Rules for Balancing Redox Reactions.

Acids and Bases: Brønsted-Lowry Concept, Lewis Concept, Acid Base Strength, pH, Acid-Base Titration, Indicators, Buffers, Henderson-Hasselbalch Equation, Hard and Soft Acids and Bases.

Thermochemistry: Work, Heat, and Energy, The Internal Energy, Enthalpy, Adiabatic Changes, Exact and Inexact Differentials, Changes in Internal Energy, The Joule–Thomson Effect, Enthalpy, Enthalpies of Formation, Enthalpies of Combustion, Hess's law, Heat Capacity and Specific Heat.

References:

1. Physical Chemistry, 11th Edition, Peter Atkins, Julio de Paula, James Keeler, Oxford University Press.
2. Chemical Principles: The Quest for Insight, 7th Edition, Peter Atkins, Loretta Jones and Leroy Laverman, W. H. Freeman Publisher.

MAT 1201	**Vector Calculus and Complex Analysis**	**3 Credits, 3 Hours/Week**

Vector Calculus

Vector Differential Calculus: Vectors in 2-Space and 3-Space, Inner Product, Cross Product, Vector and Scalar Functions and their Fields, Derivatives, Curves, Arc Length, Curvature, Gradient of a Scalar Field. Directional Derivative, Divergence of a Vector Field, Curl of a Vector Field.

Vector Integral Calculus: Line Integrals, Path Independence of Line Integrals, Green's Theorem in the Plane, Surfaces for Surface Integrals, Surface Integrals, Triple Integrals, Gauss Divergence Theorem, Stokes's Theorem, Applications of Gauss Divergence and Stokes's Theorem.

Complex Analysis

Complex Numbers, Functions and Differentiation: Complex Numbers and their Geometric Representation, Derivative, Analytic Function Cauchy–Riemann Equations, Laplace's Equation, Exponential Function, Trigonometric and Hyperbolic Functions, Euler's Formula, Logarithm, General Power and Principal Value.

Complex Integration: Line Integral in the Complex Plane, Cauchy's Integral Theorem and Formula, Power Series, Taylor and Maclaurin Series, Laurent Series Pole Singularities and Zeros, Cauchy's Residue Theorem, Residue Integration Method, Residue Integration of Real Definite Integrals.

References:

1. Mathematical Methods for Physics and Engineering, 3rd Edition, K. F. Riley, M. P. Hobson, and S. J. Bence, Cambridge University Press.
2. Advanced Engineering Mathematics, 10th Edition, Erwin Kreyszigm Herbert Kreyszig and Edward J. Norminton, John-Wiley and Sons.
3. Mathematical Method for Physicist, 6th Edition, George B. Arfken and Hans J. Weber, Elsevier Academic Press.
4. Schaum's Outline of Advanced Mathematics for Engineers and Scientists, 1st Edition, Murray R. Spiegel, McGraw Hill.

CSE 1202	**Computer Programming Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **CSE 1201**

CHE 1202	**Chemistry Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **CHE 1201**

PHY 1204	**Physics Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **PHY 1203**

2nd Year 1st Semester

EEE 2101	**Analog Electronics I**	**3 Credits, 3 Hours/Week**

PN Junction Diode and Diode Circuits: Semiconductor Materials, Construction of PN Junction, Formation of Depletion Layer and Barrier Voltage in PN Junction, Current-Voltage Characteristics of a PN Junction Diode, Equivalent Circuit of Diode, Resistance and Capacitance of PN Junction, Diode Circuit and Load Line, Zener Diode Operation and Application, Half -Wave and Full-Wave Rectifier, Voltage Multiplier, Clipper and Clamper.

Bipolar Junction Transistors (BJT): Construction and Operation of BJT, Amplifying Action, Characteristics of BJT in Common Base (CB), Common Emitter (CE) and Common Collector (CC) Configurations, α and β, Q-Point and

Load Line, Different Biasing Circuits, Stability Factor, BJT as a Switch, r_e and Hybrid Equivalent Circuit of BJT.

Single Stage BJT Amplifier Circuits: Operation of Single-Stage Amplifier, Voltage and Current Gain, Input and Output Impedance of CB, CE, CC Configurations using h-Parameter, Effect of Unbypassed R_E, R_S.

Field Effect Transistor (FET): JFET Structure, Operation and Characteristics, h-Parameters for JFET, MOSFET Construction, Operation and Characteristics, Biasing Circuits of JFET and MOSFET, Single-stage JFET Amplifier, MOSFET as a Switch, CMOS Inverter.

Multistage and Differential Amplifiers: RC Coupled Two Stage Amplifiers, Direct-coupled Amplifier, Darlington Pair, Multistage Frequency Effects.

Feedback Amplifiers: Principle of Feedback Amplifier, Positive and Negative Feedback, Advantages of Negative Feedback, Gain Stability, Decreased Distortion, Increased Bandwidth, Forms of Negative Feedback, Practical Feedback Circuits.

References:

1. Electronic Devices and Circuits, 5th Edition, David Bell, Oxford University Press.
2. Electronic Devices and Circuit Theory, Paperback Edition, R. Boylestad and L. Nashelsky, Pearson.
3. Electronic Devices and Circuits, Allen Mottershead, Goodyer Pub. Co.
4. Electronic Principles, Paperback Edition, Albert Malvino and David Bates, McGraw Hill.
5. Electronic Circuits: Discrete and Integrated, Paperback Edition, Donald Schilling, Charles Belove, and Raymond Saccardi, McGraw Hill.
6. Microelectronics, 2nd Edition, Jacob Millman and Arvin Grabel, McGraw Hill.
7. Microelectronic Circuits: Theory and Applications, 7th Edition, Adel S. Sedra, Kenneth C. Smith and Arun N. Chandorkar, Oxford University Press.

EEE 2103	**Digital Electronics**	**3 Credits, 3 Hours/Week**

Introductory Concepts: Digital and Analog Quantities, Binary Digits, Logic Levels, Digital Electronic Signals and Switches, Basic Logic Functions, Combinational and Sequential Logic Functions, Introduction to Programmable Logic and Fixed-Function Logic Devices.

Number Systems, Operations, and Codes: Decimal, Binary, Hexadecimal, Octal and Binary Coded Decimal Number Systems, Binary Arithmetic and Digital Codes.

Logic Gates: Inverter, AND Gate, OR Gate, NAND Gate, NOR Gate, Exclusive-OR and Exclusive-NOR Gate, Universal Gate, Programmable Logic, Fixed-Function Logic Gates.

Boolean Algebra and Logic Simplification: Boolean Operations, Expressions, Laws and Algebra, De Morgan's Theorems, Boolean Analysis of Logic Circuits, The Karnaugh Map, Don't Care Conditions, SOP and POS Minimization.

Arithmetic Operations and Circuits: Half and Full Adders, Half and Full Subtractor, 2's complement, Ripple Carry and Look-Ahead Carry Adders, BCD Adders, Cascading BCD Adders, Multipliers.

Functions of Combinational Logic: Decoders: 1-of-8 decoders, BCD-to-Decimal Decoder/Driver, BCD-to-7-Segment Decoder/Drivers, Decoder IC, Encoders and Applications, Priority Encoders, Code Converters, Magnitude Comparators, Parity Generators/Checkers, Multiplexers: Two, Four, Eight, Sixteen, Quad Two-Input MUX, Multiplexer Applications: Data Routing, Parallel-to-Serial Conversion, Logic Functions Generation, Demultiplexers and its Applications, 1-Line-to-8-Line Demultiplexer, Synchronous Data Transmission.

Sequential Logic: NAND/NOR Gate Latch, Edge-Detector Circuit, Flip-Flops: Clocked S-C Flip-Flop, Clocked J-K Flip-Flop, Clocked D Flip-Flop, T Flip-Flop, Master/Slave Flip-Flop, Clocked J-K Flip-Flop with Asynchronous Inputs, Flip-Flop Applications: Edge Detection, Switch Bouncing Reduction, Parallel Data Transfer, Serial Data Transfer.

Shift Registers and Counters: Shift Register Operations, Types of Shift Register, Shift Register Counters: Ring Counter and Johnson Counter, Asynchronous Counters, IC Asynchronous Counters, Asynchronous Down Counters, Synchronous Up/Down Counters, Pre-settable Counters, Counter with Arbitrary Sequences, Design of Synchronous Counters and Cascaded Counters.

Interfacing with the Analog World: Methods of Digital-to-Analog Conversion: Weighted Resistors Converter, R-2R Ladder Converter, Methods of Analog-to-Digital Conversion: Flash, Digital Ramp, Successive Approximation Converter, ADC and DAC Applications.

Integrated-Circuit Logic Families: Characteristic Parameters, The TTL Logic Family, TTL Series Characteristics, TTL Circuit Operation, Current-Sinking and Sourcing Action, Totem-Pole Output Circuit, TTL Series Characteristics, TTL Loading, Fan-In and Fan-Out, TTL NOR Gate, TTL NAND Gate, Digital MOSFET Circuits: CMOS, NMOS and PMOS Gates, Emitter-Coupled Logic, Direct Coupled Transistor Logic, Resistor Transistor Logic.

Finite State Machines: State Diagram, Moore-type and Melay-type Machines, State Machines Synthesis, State Machines in Verilog, State Encoding.

Introduction to Programmable Logic Device: Programmable Logic Device (PLD), Programmable Logic Array (PLA), Field-Programmable Gate Array (FPGA).

References:

1. Digital Systems, 12th Edition, Ronald Tocci, Neal Widmer and Greg Moss, Pearson.
2. Digital Fundamentals, 11th Edition, Thomas L. Floyd, Pearson.
3. Digital Electronics: A Practical Approach, 8th Edition, William Kleitz, Prentice Hall.
4. Digital Electronics: Principles, Devices and Applications, Anil K. Maini, John Wiley and Sons Pub. Ltd.

EEE 2105	**Solid State Physics**	**3 Credits, 3 Hours/Week**

What Holds Solids Together: Ionic Bonds, Covalent Bond, Molecular Orbital, van der Waals bonding, Fluctuating Dipole Forces, Metallic Bonding, Hydrogen Bonds, Covalent, Ionic and Molecular Crystals.

Geometry of Solids: Lattices and Unit Cells, Lattices in Three Dimensions, Bravais Lattice, Primitive Unit Cell, Wigner-Seitz Cell, The Body-Centered Cubic (bcc) Lattice, The Face-Centered Cubic (fcc) Lattice, Reciprocal Lattice, Lattice Planes, Miller Indices, Brillouin Zones, The Laue and Bragg Conditions for X-ray Diffraction, The Structure Factor.

Electrons in Solid: Electrons in a Periodic Potential, Kronig-Penney Model, Bloch's Theorem, Energy Bands in Solids, Reduced and Extended Brillouin Zone, Bandgap, Metal, Insulator and Semiconductor, Direct and Indirect Bandgap Material, The Concept of Hole, Effective Mass of Electron, Group Velocity of Electron.

Phonons in Solid: Crystal Vibrations, Mono and Diatomic Crystal Chain, Atomic Potential, Dispersion and Normal Modes, Quantization of Elastic Waves, Quantum Modes: Phonons and its Spectrum, Long Wavelength Limit, Goldstone Modes, Crystal Momentum.

Free Electron Theory of Metal: The Free Electron Gas, Free Fermi Gas at Absolute Zero Temperature, Fermi-Dirac Distribution, Fermi Surface and Sphere in Metal, The Specific Heat Capacity of Electrons in Metal.

Electron Emission: Work Function, Surface Potential Barrier, Contact Potential, Ohmic and Rectifying Contacts, Thermionic Emission: Richardson-Dushman Equation, Schottky Effect, Field Emission: Fowler-Nordheim Equation, Secondary Emission, Secondary Multipliers, Photoelectric Effect and Emission, Thermo-electricity for Metal and Semiconductors, Electron Ballistics, Lorentz Equation and its Application, Child-Langmuir Three Halves Power Law.

References:

1. Solid State Physics, 1st Edition, Neil W. Ashcroft and N. David Mermin, Cengage Learning.
2. The Oxford Solid State Basics, 1st Edition, Steven H. Simon, Oxford University Press.
3. Introduction to Solid State Physics, 8th Edition, Charles Kittel, Wiley.
4. Solid-State Physics: An Introduction to Principles of Materials Science, Harald Ibach and Hans Lüth, Springer.
5. Electronic Properties of Materials, 4th Edition, Rolf E. Hummel, Springer.
6. Band Theory and Electronic Properties of Solids, 1st Edition, John Singleton, Oxford University Press.
7. Electronic Processes in Materials, Leonid V. Azaroff and James J. Brophy, McGraw-Hill.

EEE 2107	Electromechanical Energy Conversion I	3 Credits, 3 Hours/Week

Electromagnetic Circuits: Magnetic Field, Magnetic Circuit, Comparison between Magnetic and Electric Circuits, Magnetization, Magnetic Hysteresis, Hysteresis Loss, Leakage Flux, Faraday's Laws of Electromagnetic Induction, Induced EMF, Self and Mutual Inductance, AC Excitation in Magnetic Circuit, Eddy Current Loss.

DC Generator: Main Constructional Features, Simple Loop Generator, Commutator, Armature Coils, Brushes, Armature Winding, Characteristics of Lap and Wave Winding, EMF and Torque Equation, Armature Reaction, Methods of Commutation, Types of DC Generators, No-load and Load Characteristics of Shunt, Series and Compound Generators, Losses and Efficiency of DC Generators.

DC Motors: Working Principle of DC Motors, Back EMF and EM Torque, Series and Shunt DC Motors, Starting of Shunt and Compound Wound DC Motors, Speed Control of DC Motors, Electrical Braking of DC Motor, Losses in DC Motor, Efficiency of DC Motor.

Single-Phase Transformers: Working Principle of a Transformer, Core Material and Construction, Transformer Winding, EMF Equation, An Ideal Transformer, Transformer on No-load and Load, Transformer Winding Resistance, Mutual and Leakage Fluxes, Equivalent Reactance, Equivalent Circuit for an Actual Transformer, Voltage Regulation, Losses in a Transformer, Efficiency of a Transformer, Transformer Tests: Voltage Ratio, Open-circuit or No-load Test, Short Circuit Test, Back-to-Back Test, Parallel Operation and Load Sharing of Transformers, Auto-transformer.

Three-Phase Transformers: Merits and Construction of Three Phase Transformer, Relative Primary and Secondary Windings, Polarity of Transformer

Windings, Phasor Representation, Three-Phase Transformer Connections, Selection of Transformer Connections: Star-Star, Delta-Delta, Star-Delta Connections, Delta-Star and Delta-Zigzag, Parallel Operation of Three-Phase Transformers, Load Sharing between Three-Phase Transformers, No-load and Load Tap-Changers on Transformers, Transformation of Three-Phase Power with Two Single-Phase Transformers, Open-Delta or V-V and T-T Connections, Conversion of Three-Phase to Two-Phase and Vice-Versa, Difference between Power and Distribution Transformers, Power Transformer.

References:

1. Electrical Machines, 1st Edition, S. K. Sahdev, Cambridge University Press.
2. Electric Machinery Fundamentals, 5th Edition, Stephen J. Chapman, McGraw-Hill Education.
3. Electric Machinery, 6th Edition, A.E. Fitzgerald, Charles Kingsley JR and Stephen D. Uman, McGraw-Hills.
4. Electric Machines: Theory, Operating Applications, and Controls, 2nd Edition, Charles I. Hubert, Pearson.

EEE 2109	Signals and Systems	3 Credits, 3 Hours/Week

Signals: Classification of Signals, Basic Operations on Signals, Elementary Signals, The Concept of Frequency in Continuous-Time and Discrete-Time Signals, Analog-to-Digital and Digital-to-Analog Conversion.

Systems: Input-Output Description of Systems, Classification of Systems, Properties of Systems, Interconnection of Systems.

Linear Time-Invariant (LTI) Systems: Response of Continuous-Time LTI System and Convolution Integral, Response of a Discrete-Time LTI System and Convolution Sum, Recursive and Non-Recursive Systems, Differential and Difference Equation Representations of LTI Systems, Solution of Differential and Difference Equations, State Variable Descriptions of LTI Systems, Structures for the Realization of LTI Systems.

Fourier Analysis of Signals and Systems: Fourier Representations of Signals, The Fourier series, The Discrete-Time Fourier Series, The Fourier Transform, The Discrete-Time Fourier Transform, Properties of Fourier Representations, Parseval's Theorem, Power Density Spectrum and Energy Density Spectrum.

Applications of Fourier Analysis: Frequency Response of LTI Systems to Complex Exponential Signals, Filtering and Bandwidth, Frequency Analysis-Analog Electrical Systems, Sampling and Reconstruction of Signal, Convolution and Multiplication with Mixtures of Periodic and Non-periodic Signals,

Modulation and Demodulation, Time-Division and Frequency-Division Multiplexing.

The Laplace Transform: Definition, Properties, Convergence of Laplace Transform, Initial-value and Final-Value Theorem, Inverse Laplace Transform, Partial-fraction Expansions, Heaviside Expansion Formula, Solution of Differential Equation, System Transfer Function, System Stability, Electrical Network Analysis.

References:

1. Signals and Systems, 2nd Edition, Simon Haykin and Barry Van Veen, Wiley Inc.
2. Signals and Systems, 2nd Edition, Alan V. Oppenheim, Alan S. Willsky and S. Hamid, Pearson Education.
3. Linear Systems and Signals, 3rd Edition, B.P. Lathi and Roger Green, Oxford University Press.
4. Signals and Systems, 1st Edition, Sanjit K. Mitra, Oxford University Press
5. Continuous and Discrete-Time Signals and Systems, 2nd Edition, Samir S. Soliman and Mandyam D. Srinath, Prentice-Hall of India.

MAT 2101	Ordinary and Partial Differential Equations	3 Credits, 3 Hours/Week

Ordinary Differential Equations (ODEs)

First-order ODE: General Form of Solution, First-degree First-order Equations, Separable-variable Equations, Exact Equations, Inexact Equations, Integrating Factors, Linear Equations, Homogeneous Equations, Isobaric Equations, Bernoulli's Equation, Existence and Uniqueness of Solutions for Initial Value Problems, Higher-Degree First-Order Equations, Clairaut's Equation.

Second-Order ODEs: Homogeneous Linear ODEs of Second Order, Homogeneous Linear ODEs with Constant Coefficient, Euler–Cauchy Equations, Existence and Uniqueness of Solutions, Wronskian, Nonhomogeneous ODEs, Method of Undetermined Coefficients, Solution by Variation of Parameters.

Series Solutions of ODEs: Power Series Method, Legendre's Equation and Legendre Polynomials, Bessel's Equation and Bessel Functions, Laguerre Differential Equation and Laguerre Polynomials, Airy Differential Equation, Hermite Differential Equation and Hermite Differential Polynomials.

Partial Differential Equations (PDEs)

Important Partial Differential Equations: The Wave Equation, The Diffusion Equation, Laplace Equation, Poisson's Equations, Schrodinger's Equation.

Solving PDEs: General and Particular Solutions, Separation of Variables, Superposition of Separated Solutions, Separation of Variables in Polar Coordinates, Laplace Equation in Polar Coordinates, Spherical Harmonics, Helmholtz's Equation, Integral Transform Methods, Inhomogeneous PDE Problems with Green's Functions Approach.

References:

1. Mathematical Methods for Physics and Engineering, 3rd Edition, K. F. Riley, M. P. Hobson, and S. J. Bence, Cambridge University Press.
2. Advanced Engineering Mathematics, 10th Edition, Erwin Kreyszigm Herbert Kreyszig and Edward J. Norminton, John-Wiley and Sons.
3. Mathematical Method for Physicist, 6th Edition, George B. Arfken and Hans J. Weber, Elsevier Academic Press.
4. Schaum's Outline of Advanced Mathematics for Engineers and Scientists, 1st Edition, Murray R. Spiegel, McGraw Hill.
5. Schaum's Outline of Differential Equations, 4th Edition, Richard Bronson and Gabriel Costa, McGraw Hill.
6. Schaum's Outline of Partial Differential Equations, 3rd Edition, Paul Du Chateau and D. W. Zachmann, McGraw Hill.

EEE 2102	**Circuit Simulation Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory Based on **EEE 1101** and **EEE2101**

EEE 2104	**Digital Electronics Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory Based on **EEE 2103**

2nd Year 2nd Semester

EEE 2201	**Analog Electronics II**	**3 Credits, 3 Hours/Week**

Operational Amplifiers (Op-Amp): Differential Amplifier-Voltage Gain, Input Impedance and Output Impedance, CMRR, Basic Construction of Op-Amp, Different Parameters of Op-Amp, Properties of Ideal Op-Amps, Frequency Response of an Op-Amp, Inverting and Non-Inverting Amplifier, Summing and Difference Amplifier, Current-to-Voltage Converter, Voltage Follower, Differentiator, Integrator, Op-Amp Comparator, Op-Amp Schmitt-Trigger Circuit,

Multivibrators using Op-Amp, Precision Rectifier and Other Applications, Active Filters- Different Types of Filters and Specifications, Transfer Functions, Design and Construction of First and Second Order Low, High and Band Pass Filters using Op-Amps.

Oscillators: Basic Principle of Oscillator, Bark-Hausen Criterion for Oscillation, Phase Shift Oscillators, Wein Bridge Oscillator, Bridge-Tuned Twin T Oscillator, LC Oscillators– Hartley and Colpitts, Negative Resistance Oscillator, Crystal Oscillator, Frequency Stability.

Power and Tuned Amplifiers: Class A, Class B, Class AB Power Amplifier, Transformer-Coupled Class A Amplifier, Push-Pull Amplifier, Complementary Symmetry, Quasi-Complementary, Class-D Amplifier, Tuned Amplifier, Single Tuned Amplifier, Double Tuned Amplifier, Stagger Tuned Amplifier.

Pulse and Switching Circuits: Classification of Multivibrator, Astable, Monostable, Bistable Multivibrator with BJT, 555 Timer IC, Astable, Monostable, Bistable Multivibrator with 555 IC, Bistable Triggering Problem, Schmitt Trigger with BJT, Blocking Oscillators, Voltage and Time Base Generators, Exponential Sweep Circuits, Constant Current Charging Circuit, Sweep Circuit for TV Receivers, Pulse Transformer.

Voltage Regulators: Series and Shunt Regulations, Methods to Improve the Regulators, IC Voltage Regulators, Switching Regulators.

Phase Locked Loops: Basic PLL, Major Building Blocks, Lock and Capture Range, Applications of PLL, FM Demodulation, FSK Demodulation, AM Demodulation, Frequency Synthesizer.

References:

1. Op-amps and Linear Integrated Circuit Technology, 2nd Edition, Ramakant A Gayakwad, Prentice-Hall.
2. Solid State Pulse Circuits, David A. Bell, Oxford University Press.
3. Operational Amplifiers and Linear Integrated Circuits, 6th Edition, Robert F. Coughlin and Frederick F. Driscoll, Pearson.
4. Op Amps for Everyone, 4th Edition, Bruce Carter, Newnes.
5. Electronic Devices and Circuit Theory, Paperback Edition, R. Boylestad and L. Nashelsky, Pearson.
6. Electronic Circuits: Discrete and Integrated, Paperback Edition, Donald Schilling, Charles Belove, and Raymond Saccardi, McGraw Hill.
7. Microelectronics, 2nd Edition, Jacob Millman and Arvin Grabel, Tata McGraw Hill.
8. Microelectronic Circuits: Theory and Applications, 7th Edition, Adel S. Sedra, Kenneth C. Smith and Arun N. Chandorkar, Oxford University Press.
9. Electronic Principles, Paperback Edition, Albert Malvino and David Bates, McGraw Hill.

EEE 2203	Electromechanical Energy Conversion II	3 Credits, 3 Hours/Week

Synchronous Generators: General Aspects and Principles of Synchronous Machines, Generator and Motor Action, Alternating EMF, Relation between Frequency, Speed and Number of Poles, Constructional Features of Synchronous Machines, Excitation Systems, Armature Winding, Two and Three Phase Rotating Magnetic Field, Armature Resistance, Leakage Reactance and Armature Reaction, Equivalent Circuit and Phasor Diagram, Voltage Regulation, Losses and Efficiencies in Synchronous Generators, Parallel Operation of Alternators, Synchronising Single and Three Phase Alternators and Synchronising Current, Power and Torque.

Synchronous Motors: Construction, Working Principle and Equivalent Circuit of a Synchronous Motor, Phasor Diagram, Relation between Supply and Excitation Voltage, Torques in a Synchronous Motor, Power Flow in Synchronous Motor, Salient-pole Synchronous Motor, V- Curve and Inverted V-Curve, Effect of Load and Excitation Change, Methods of StartingSynchronous Motor, Synchronous Condenser, Hunting and Applications of Synchronous Motors.

Three-Phase Induction Motors: Constructional and Operational Principle, Production of Revolving Field, Reversal of Direction of Rotation, Slip, Speed of Rotor Field, Rotor EMF, Resistance, Reactance, Impedance, Current and Power Factor, RotorEquivalent Circuit, Stator Parameters, Induction Motor on No-load and on Load, Constant and Variable Losses, Power Flow, Rotor Efficiency, Torque Development, Effect of Load and Voltage on Torque, Torque-Slip Curve, Stator Resistance, Voltage-Ratio Test, No-load Test, Blocked Rotor Test.

Starting and Speed Control Methods: Squirrel Cage Induction Motors, Slip-Ring Induction Motors, Starting Methods of Squirrel Cage Induction Motors, Direct on Line (D.O.L.) Starter, Stator Resistance (or Reactance) Starter, Star-Delta Starter, Auto-Transformer Starter, Rotor Resistance Starter for Slip Ring Induction Motor, Speed Control by Changing the Slip, Rotor Circuit Resistance, Supply Voltage, Voltage in the Rotor Circuit, Supply Frequency, Changing the Poles, and Rotor EMF Injection.

Single-Phase Induction Motor: Classification of Single-Phase Motors, Single-Phase Induction Motors, Torque and Field in Single-Phase Induction Motors, Equivalent Circuit, Methods of Self-Starting.

Special Machines: DC Servomotors, Brushless DC Motors, Brushless Synchronous Generator, Brushless Synchronous Motor, Stepper Motors: Permanent Magnet and Variable Reluctance Type.

References:

1. Electrical Machines, 1st Edition, S. K. Sahdev, Cambridge University Press.

2. Electric Machinery Fundamentals, 5th Edition, Stephen J. Chapman, McGraw-Hill Education.
3. Electric Machinery, 6th Edition, A.E. Fitzgerald, Charles Kingsley, JR and Stephen D. Uman, McGraw-Hills.
4. Electric Machines: Theory, Operating Applications, and Controls, 2nd Edition, Charles I. Hubert, Pearson.

MEC 2201	Fundamentals of Mechanical Engineering	3 Credits, 3 Hours/Week

Heat: The Concept of Heat, Heat Transfer: Conduction, Convection and Radiation, Concept of Temperature, Thermal Equilibrium, Micro and Macro State, Boltzmann Factor, Energy Transfer by Work and Heat.

Thermodynamics: Laws of Thermodynamics: Zeroth, First, Second and Third Law of Thermodynamics, The Carnot Engine, Carnot's Theorem, Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Function, Gibbs Function, Maxwell's Relations, The Chemical Potential, Shannon Entropy and Information, Thermodynamic Processes: Isothermal and Adiabatic, Reversible and Irreversible Processes.

Refrigeration: The Performance of Refrigeration Systems, The Theoretical Single-Stage Compression Cycle, Refrigerants, Refrigeration Equipment Components, The Real Single-Stage Cycle, Absorption Refrigeration.

Air-Conditioning: The Complete System, System Selection and Arrangement, HVAC Components and Distribution Systems, Types of All-Air Systems, Air-and-Water Systems, All-Water Systems, Decentralized Cooling and Heating, Heat Pump Systems, Heat Recovery Systems, Thermal Energy Storage.

Fluid Mechanics: Introduction to Fluid Flow, Pathlines, Streamlines and Streaklines, Angular Velocity, Vorticity, and Strain, Circulation, Stream Function, Velocity Potential, Inviscid and Incompressible Flow: Bernoulli's Equation, Condition on Velocity for Incompressible Flow, Inviscid and Compressible Flow: Governing Equation and Condition for Total Stagnation, Viscous Flow: Navier-Stokes Theorem.

Mechanical Properties of Solids: Stress and Strain, Elasticity, Stress–Strain Curves, Torsion Test, Bend Test, Hardness Test, Slip and Crystallographic Textures, Dislocation Geometry and Energy, Mechanical Properties of Engineering Material: Tensile Strength, Hardness, Fatigue, Impact Strength, Creep.

Mechanical Engines: Stream Engines, Internal Combustion Engines, Gas Turbine Engines.

References:

1. Concepts in Thermal Physics, 2nd Edition, Stephen J. Blundell and Katherine M. Blundell, Oxford University Press.
2. Thermodynamics: An Engineering Approach, 8th Edition, Yunus A. Cengel Dr and Michael A. Boles, McGraw Hill Education.
3. Thermal Physics, 2nd Edition, Charles Kittel and HerbertKroemer, W. H. Freeman Publication.
4. An Introduction to Thermal Physics, 1st Edition, Daniel V. Schroeder, Pearson.
5. Heating, Ventilating, and Air Conditioning Analysis and Design, 6th Edition, Faye C. McQuiston, Jerald D. Parker and Jeffrey D. Spitler, John-Wiley & Sons, Inc.
6. Fundamentals of Aerodynamics, 6th Edition, John D. Anderson, Jr., McGraw-Hill Education.
7. Mechanical Behavior of Materials, 2nd Edition, William F. Hosford, Cambridge University Press.

STA 2201	**Probability and Statistics**	**3 Credits, 3 Hours/Week**

Introduction: Modern Statistics, Statistics and Engineering.

Probability: Sample Spaces and Events, Counting, The Axioms of Probability, Theorems of Probability, Conditional Probability, Baye's Theorem, Mathematical Expectation and Decision Making.

Probability Distributions: Random Variables, The Binomial Distribution, The Hypergeometric Distribution, The Mean and Variance of a Probability Distribution, Chebyshev's Theorem, The Poisson approximation to the Binomial Distribution, Poisson Processes, The Geometric Distribution, The Multinomial Distribution.

Probability Densities: Continuous Random Variables, The Normal Distribution, The Normal Approximation to the Binomial Distribution, The Uniform Distribution, The Weibull Distribution, Joint Probability Densities.

Treatment of Data: Frequency Distributions, Graphs of Frequency Distributions, Stem-and-Leaf Plots, Descriptive Measures.

Sampling Distributions: Population and Samples, The Sampling Distribution of the Mean (known), The Sampling Distribution of the Mean (unknown), The Sampling Distribution of Variance.

Inferences Concerning Means: Point Estimation, Tests of Hypotheses, Null Hypotheses and Significance Tests, Hypotheses Concerning One Mean, Operating Characteristic Curves, Hypotheses Concerning Two Means.

Inferences Concerning Variances: The Estimation of Variances, Hypotheses Concerning One Variance, Hypotheses Concerning Two Variances.

Inferences Concerning Proportions: Estimation of Proportions, Bayesian Estimations, Hypotheses Concerning One Proportion, Hypotheses Concerning Two Proportions, The Analysis of rc Tables, Goodness of Fit.

Nonparametric Tests: The Sign Test, Test of Randomness, The Rank-Sum Tests.

Regression Analysis: The Method of Least Squares, Inferences Based on Least Square Estimators, Multiple Regression, Correlation.

Analysis of Variance: General Principles, Completely Randomized Designs, Randomized Block Designs, Multiple Comparisons.

Factorial Experiments: Two-Factor Experiments, Multifactor Experiments, 2^{nd} Factorial Experiments, Confounding in a 2^{nd} Factorial Experiment, Fractional Replication.

References:

1. Probability and Statistics for Engineers, 9^{th} Edition, by Irwin Miller and John Freund, Pearson.
2. Probability & Statistics for Engineers & Scientists, 9^{th} Edition, Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Pearson Education.
3. Introduction to Probability and Statistics for Engineers and Scientists, 5^{th} Edition, Sheldon M. Ross, Academic Press.

GED 2201	**Fundamentals of Economics**	**3 Credits, 3 Hours/Week**

Introduction to Economics: The Central Economic Problem of Scarcity and Choice, Human Economic Behaviour, Opportunity Cost, Micro and Macro Economics, Factors of Production, Difference between Resource and Wealth, Free Goods and Economic Goods, Public and Private Goods, Different Economic Systems.

Types of Production: Primary, Secondary and Tertiary Production, The Market Economy: Elements of Demand and Supply, Causes of Changes in Demand and Supply, Elasticity of Demand and Supply, The Price Mechanism, Theory of Utility and Preferences, Consumer's Surplus, Theory of Production and Cost.

Theory of the Firm: Economies of Scale, Monopoly vs Competition, Private Enterprise: Definition and Objective, Types of Private Enterprise: Sole Traders, Partnerships, Joint Stock Companies, Holding Companies, Cooperatives, Public Enterprise: Definition, Nationalization, and Privatization.

The Circular Flow: National Income and Economic Growth, National Income Accounting, The Simple Keynesian Analysis of National Income, Savings, Investment, Fiscal Policy: Meaning, Taxation, Direct and Indirect Taxation.

Government Spending: Definition, Objective and Impact, Budgetary Policy: Surplus Budget, Deficit Budget, Balanced Budget, Money and Banking: Definition of Money, Functions of Money, Characteristics of Good Monetary Medium.

Banks: Functions of Commercial Banks, Functions of Central Bank, International Trade: Advantages of International Trade, Terms of Trade, Methods of Protection, Balance of Payments, Exchange Rates, Balance of Payment Deficits and Surpluses, Role of IMF, GATT.

Economic Problem: Inflation, Economic Growth and Unemployment, Causes of Inflation, Instrument to Control Inflation.

Poverty: Types of Poverty**,** Causes of Poverty, Poverty Reduction and Eradication Measures, Social Safety Nets.

Economic Depression: Causes of Economic Depression, Indicators of Economic Depression, Recovery.

Globalization: Definition, Globalization of Capital, New Liberal Policy, Impact of Globalization, Ideas about Environmental and Ecological Economics, Concept of Information Economics and Behavioural Economics, Ideas about Evolution of Economic Thoughts.

References:

1. Economics, 19th Edition, Paul A Samuelsonand William D Nordhaus, McGraw-Hill Education.
2. Macroeconomics, 8th Edition, N. Gregory Mankiw, Worth Publishers.
3. Microeconomic Analysis Paperback, 3rd Edition, Hal R. Varian, W. W. Norton & Company.

EEE 2202	**Analog Electronics Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 2101 and EEE 2201**

MEC 2202	**Mechanical Engineering Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **MEC 2201**

EEE 2204	**Electromechanical Energy Conversion Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 2107** and **EEE 2203**

3rd Year 1st Semester

EEE 3101	Electromagnetic Theory and Antenna	3 Credits, 3 Hours/Week

Electromagnetics: Maxwell's Equation: Differential and Integral Forms, Constitutive Relations, Complex Dielectric Constant, Linear and Nonlinear Mediums, Boundary Conditions for Different Interfaces, Poynting Theorem, Potential Functions, Vector Wave Equation, Wave Equation in 3D, Uniform Plane Wave (UPW) in Lossless Medium, UPW in Lossy Medium, Skin Depth, DC and AC Resistance, Loss Tangent.

Transmission Line (TL): TL EquivalentCircuit of a Small Section, TL Equations or Telegraph's Equations, Characteristic Impedance, Quarter-Wave Transformer, Reflection Coefficient, VSWR, Determining Unknown Load-Impedance, Impedance Matching and Tuning using Smith Chart, Microstrip Lines.

Waveguides: Rectangular and Cylindrical, TE and TM Modes, Dominant/ Fundamental Mode, Single-Multimode, Cut-off Frequency/Wavelength, Power Flow, Resonant Cavities and Dielectric Slab Waveguide.

Antenna: Radiation Mechanism of Antenna, Types of Antennas, Radiation Patterns, Major and Minor Lobes, Equivalent Circuit of a Transmitting Antenna, Generated and Radiated Power Ratio, Near and Far Field Approximations, Antenna Efficiency, Effective Aperture, Antenna Beamwidthand Bandwidth, Wire Antennas such as Hertzian, Half-Wave Dipole and Monopole, Expressions for Surface Power Density or Poynting Vector, Radiation Intensity, Directivity, Gain, Radiation Resistance and Radiation Pattern for Far Fields, Antenna Arrays: Array Factor, Main Lobe Direction, Nulls, Secondary Maxima, HPBW, Broadside Array, End-Fire Array, Horns, Reflector Type Antennas, Frequency Independent Antennas, Microstrip Patch Antennas, Antenna Measurements.

References:

1. Microwave Engineering, 4th Edition, David M. Pozar, John Wiley & Sons, Inc.
2. Elements of Electromagnetics, 4th Edition, Matthew N.O. Sadiku, Oxford University Press.
3. Fundamentals of Applied Electromagnetics, 6th Editon, F.T. Ulaby, Prentice Hall, Boston.
4. Microwave Devices and Circuits, 3rd Edition, Y. Liao, Prentice Hall.
5. Antenna Theory: Analysis and Design, 4th Edition, Constantine A. Balanis, Wiley.
6. Antennas and Wave Propagation, G.S.N. Raju, Pearson.
7. Electronic Communications, 4th Edition, Dennis Roddy and John Coolen, Pearson.
8. Radio Frequency and Microwave Electronics Illustrated, 1st Edition, Matthew M. Radmanesh, Prentice Hall.

9. Foundations for Microwave Engineering, 2nd Edition, Robert E Collin, Wiley.
10. Engineering Electromagnetics, 8th Edition, William Hayt and John Buck, McGraw-Hill Education.
11. Advanced Engineering Electromagnetics, 2nd Edition, Constantine A. Balanis, Wiley.

EEE 3103	Microprocessor and Interfacing	3 Credits, 3 Hours/Week

Introduction to Microprocessor: Microcomputer System, Classification and Evolution of Microprocessor, Difference between Microprocessor and Microcontroller.

8086 Microprocessor: Basic Architecture, Registers, Flags, Real Mode Operation of 8086 Microprocessor, Segment, Offset and Physical Address, Instruction Format, Functions of Different Instructions of 8086 Microprocessor, Pins and Signals, Bus Buffering and Latching, Bus Timing, Ready and Wait State Generation, Clock Generator (8284A), Memory Segmentation.

Interrupts: Introduction to Interrupts, Interrupt Vector Table, Interrupt Instructions and Operation, Hardware and Software Interrupts, Interrupt Driven I/O, Programmable Interrupt Controller (8259A).

Microprocessor Programming: Introduction to Assembly Language Programming (ALP), Macro and Procedure, Program Development Tools, Program Development Process, Writing Simple ALPs using Different I/O Functions, Macro, Procedures.

Memory: Memory Types, Memory Banks, Memory Read-Write Cycle, Memory Interfacing.

I/O Interfacing: I/O Instructions, Basic I/O Interfacing, I/O Port Address Decoding, Programmable Peripheral Interface (8255A IC), Peripheral Interfacing Examples, Programmable Interval Timer (8254), Timer Interfacing, D/A and A/D Converter, Programmable Communication Interface, Interfacing Serial I/O Devices.

DMA: Basic DMA Operation, DMA Controller, DMA Processed Interface.

References:

1. The Intel Microprocessors, Architecture, Programming and Interfacing, 6th Edition, Barry B. Brey, Prentice Hall.
2. Assembly Language Programming and Organization of the IBM PC, Ytha Yu and Charles Marut, McGraw-Hill.
3. Microprocessors, PC Hardware and Interfacing, N. Mathivanan, Prentice-Hall of India.
4. Microprocessors and Interfacing, Douglas V Hall, McGraw-Hill.
5. Microprocessor X86 Programming, K. R. Venugopal and Raj Kumar, BPB Publications.

EEE 3105	Communication Systems	3 Credits, 3 Hours/Week

Overview of Communication Systems: Basic Principles, Fundamental Elements, System Limitations, Message Source, Bandwidth Requirements, Transmission Media Types, Bandwidth and Transmission Capacity.

Noise: Sources of Noise, Characteristics of Various Types of Noise and Signal to Noise Ratio.

Analog Communication Systems: Continuous Wave Modulation: Transmission Types, Base-Band Transmission, Carrier Transmission, Amplitude Modulation-Introduction, Double Side Band, Single Side Band, Vestigial Side Band, Quadrature, Spectral Analysis of Each Type, Envelope and Synchronous Detection, Angle Modulation-Instantaneous Frequency, Frequency Modulation (FM) and Phase Modulation (PM), Spectral Analysis, Demodulation of FM and PM, AM Broadcast Technical Standards, AM Transmitter and Receiver, Superheterodyne Receiver, FM Transmitters and Receivers, Comparison of AM and FM Receivers, Noise in Receiver, Noise Limiting Circuits, AGC Circuits, Receiver Sensitivity, Cross Modulation, Spurious Response Converters, Detector and Modulation Circuits, Sampling- Sampling Theorem, Nyquist Criterion, Aliasing, Instantaneous and Natural Sampling, Flat-Topped Sampling, Pulse Amplitude Modulation- Principle, Bandwidth Requirements, Pulse Code Modulation (PCM)- Quantization Principle, Quantization Noise, Nonuniform Quantization, Signal to Quantization Noise Ratio, Differential PCM, Demodulation of PCM, Delta Modulation (DM)- Principle, Adaptive DM, Delta-Sigma Modulation, Adaptive DPCM (ADPCM), Line Coding- Formats and Bandwidths.

Digital Modulation and Demodulation: Amplitude-Shift Keying-Principle, ON-OFF Keying, Bandwidth Requirements, Detection, Noise Performance, Phase-Shift Keying (PSK)- Principle, Bandwidth Requirements, Detection, Differential PSK, Quadrature PSK, Noise Performance, Frequency-Shift Keying (FSK)- Principle, Continuous and Discontinuous Phase FSK, Minimum-Shift Keying (MSK), GMSK, Bandwidth Requirements, Detection of FSK, Multilevel Signalling, M-Ary Modulation Techniques, Spread Spectrum Modulation Techniques, DSSS, FHSS.

Multiplexing: Time-Division Multiplexing (TDM), Principle, Receiver Synchronization, Frame Synchronization, TDM of Multiple Bit Rate Systems, Frequency-Division Multiplexing (FDM) Principle, Demultiplexing; Wavelength-Division Multiplexing, Multiple-Access Network- Time-Division Multiple-Access (TDMA), Frequency-Division Multiple Access (FDMA), Code-Division Multiple-Access (CDMA) Spread Spectrum Multiplexing, Coding Techniques and Constraints of CDMA.

Communication System Design: Design Parameters, Channel Selection Criteria and Performance Simulation.

References:

1. Introduction to Spread Spectrum Communications, R.L.Peterson, R.E.Ziemer and D.E. Borth, Prentice Hall.
2. Differential Geometry in Array Processing, A. Manikas, Imperial College Press.
3. Digital Communications, I. A. Glover & P.M. Grant, Prentice Hall.
4. Digital Communications Fundamentals and Applications, Sklar B, Prentice Hall.
5. Introduction to Digital Communications, R.E. Ziemer & R.L. Peterson, MacMillan.
6. Communication Systems, 4th Edition, Simon Haykin, Wiley.
7. Digital Communications Systems, 1st Edition, Simon Haykin, Wiley.
8. Communication Systems Engineering, 2nd Edition, John G. Proakis and Masoud Salehi, Pearson.
9. Probability, Random Variables and Stochastic Processes, 4th Edition, Athanasios Papoulis and S. Unnikrishna Pillai, McGraw-Hill Europe.
10. Principles of Communications: Systems, Modulation, and Noise, 4th Edition, Rodger E. Ziemer and W. H. Tranter, Wiley.
11. Modern Digital and Analog Communication Systems, 4th Edition, B.P. Lathi, Zhi Ding and Hari Mohan Gupta, Oxford University Press.
12. Principles of Communication Systems, 4th Edition, Herbert Taub, Donald Schilling and Goutam Saha, McGraw-Hill Education.

EEE 3107	**Industrial and Medical Instrumentation**	**3 Credits, 3 Hours/Week**

Electronic Instrumentation: Sine-Wave Generator, Arbitrary Function Generator, Pulse Train Generator, Sweep Frequency Generator, Spectrum Analyzer, Frequency Analyzer, Digital Voltmeter: Stair-Case, Successive Approximation Type, Integrating, Dual Slope Integrating Type, Delta Pulse Modulation Type, Cathode Ray Oscilloscope: Construction, Time Base, Waveform Display, Trigger, Probe and Control.

Displacement Instrumentation: Potentiometer, Differential Transformer, Capacitance Transducers, Rotational Speed Measurement using Tacho Generator.

Force Instrumentation: Strain Gauge, Piezo-Electric Transducers, Force Transducers, Acceleration Transducers, Torque Transducers.

Temperature Instrumentation: Resistance Thermometer Detectors (RID), Thermistors, Thermocouple, Photovoltaic Sensor, Infra-Red Thermometry, Radiation Detection.

Pressure Instrumentation: Strain Gauge Based, Capacitance Based, Thermocouple Gauge, Flow Meter: Differential Pressure Measurement, Venturi

Meter, Magnetic Flowmeter, Ultrasonic Flowmeter, Capacitive Based Level Sensor and Ultrasonic Level Sensor.

Process Instrumentation: Humidity Sensor, Density and Specific Gravity Sensor, Viscosity Sensor, Regulators and Safety Valves and Flow Control Actuators.

Biopotential Instrumentation: The Origin of Biopotentials, ECG, EEG, EMG, Biopotential Electrodes, Arrhythmia Monitor, QRS Detection Techniques, Cardiac Defibrillators, Cardiac Pacemaker.

Modern Imaging Systems: X-ray Machines, X-ray Computed Tomography, Nuclear Medical Imaging Systems, The Gamma Camera, Emission Computed Tomography, Single-Photon Emission Computed Tomography, Positron Emission Tomography, Magnetic Resonance Imaging System, Ultrasonic Imaging Systems and Thermal Imaging System.

Radiotherapy Instrumentation: High Voltage X-ray Machines, Betatron, Cobalt-60 Machine, Medical Linear Accelerator Machine.

Miscellaneous: Oximeter, Blood Flow Meter, Spectrophotometer, Blood Cell Counter, High Frequency Heat Therapy, Short-wave Diathermy, Microwave Diathermy and Ultrasonic.

References:

1. Electronic Instrumentation and Measurements, 2nd Edition, David A. Bell, Prentice Hall.
2. Modern Electronic Instrumentation and Measurement Techniques, Albert D Helfrick and William D. Cooper, Prentice Hall.
3. Industrial Instrumentation, Tattamangalam R. Padmanabhan, Springer.
4. Fundamentals of Industrial Instrumentation and Process Control, 2nd Edition, William C. Dunn, McGraw-Hill.
5. Handbook of Biomedical Instrumentation, 2nd Edition, R S Khandpur, Tata McGraw-Hill.
6. Medical Instrumentations, 4th Edition, John G. Webster, John-Wiley and Sons.

EEE 3109	**Electronic Devices**	**3 Credits, 3 Hours/Week**

Semiconductor Fundamentals: Overview of Semiconductor Applications and Silicon IC Technology, Geometry of Crystals, Review of Quantum Mechanics, Energy Bands, Intrinsic and Extrinsic Semiconductors, Fermi Levels, Electron and Hole Concentrations, Temperature Dependence of Carrier Concentrations and Invariance of Fermi Level, Density of States, Fermi-Dirac Statistics.

Carrier Transport: Drift and Diffusion, Generation and Recombination of Excess Carriers, Built-in-Field, Recombination-Generation SRH Formula, Surface

Recombination, Einstein Relations, Continuity and Diffusion Equations for Holes and Electrons and Quasi-Fermi Level.

PN Junction: Basic Structure and Operation, Energy Band Diagram under Equilibrium and Non-Equilibrium Conditions, Contact Potential, Equilibrium Fermi Level, Space Charge Region, Non-Equilibrium Condition, Forward and Reverse Bias, Carrier Injection, Minority and Majority Carrier Currents, PN Junction Electrostatics, Transient and AC Conditions, Time Variation of Stored Charge, Reverse Recovery Transient and Capacitance.

Metal-Semiconductor Junction: Ohmic Contact and Schottky Contacts, MS Junction Energy Band Diagram, PN Diode vs Schottky Diode I-V Characteristics, MS Junction Electrostatics.

Bipolar Junction Transistor: Basic Principle of PNP and NPN Transistors, Emitter Efficiency, Base Transport Factor and Current Gain, Diffusion Equation in the Base, Terminal Currents, Coupled-Diode Model and Charge Control Analysis, Ebers-Moll Model and Circuit Synthesis, BJT Non-Ideal Effects.

MOSFET: MOS Structure: MOS Capacitor, Energy Band Diagrams and Flat Band Voltage, MOS Capacitor under Applied Bias, Accumulation, Depletion, and Inversion Regions, Threshold Voltage and Control of Threshold Voltage, MOS Electrostatics, Static CV Characteristics, Qualitative Theory of MOSFET Operation, Body Effect and Current-Voltage Relationship of a MOSFET, Output and Transfer Characteristics, Non-Ideal Characteristics of MOSFET: Channel-Length Modulation and Short-Channel Effects in MOSFET, DIBL, GIDL, MOS Scaling, High K-Metal Gate and Strained MOSFETs.

Emerging Devices: Introduction to Multi-gate FET Architecture, Structure and Basic Operation of Double Gate MOSFET, FinFET, Surrounding Gate FET, High-K Dielectric FETs.

References:

1. Semiconductor Device Fundamentals, Robert F. Pierret, Addison Wesley.
2. Modern Semiconductor Devices for Integrated Circuits, 1st Edition, by Chenming Hu, Pearson India.
3. Solid State Electronic Devices, 7th Edition, B. G. Streetman and B. K. Banerjee, Pearson Higher Education
4. Semiconductor Physics and Devices, 4th Edition, Donald A. Neamen, McGraw-Hill.

IPE 3101	Industrial Management	3 Credits, 3 Hours/Week

Management: Concept of Management, Definition of Industry from Different Viewpoints, Different View of Management, Management Process Cycle,

Characteristics of Management, Different Schools of Management: Bureaucratic School, Administrative School and Scientific Management, Evolutionof Management Thought: Classical, Neo Classical and Modern Management Thoughts, Fathers of Management: Max Weber, Henry Fayol and Fredrick Tylor, Industrial Revolution and Development of Management.

Organization: Definitionof Organization, Different Types of Organization, Organization as an Open System, Boundary of an Organization, Boundaryless and Virtual Organization, Functions of Manager in an Organization, Different Types of Managers, Span of Control, Authority Delegation, Different Theories Authority, Authority, Responsibility and Accountability.

Human Resource Management: Importance of HRM, Needs Hierarchy Theory by Maslow and other Management and Psychology Experts, Theory of Motivation, Theory of Leadership, Labour Economics and Planning of Wage, Wage and Salary, Exempted and Non Exempted Employees, Different Components of Remuneration, Incentives and Equity in Salary and Wage Salary Compression, Salary Inversion, Internal and External Equity, Compa Ratio, Employee Turnover, Revenue Employee Ratio, Different Techniques of Performance Appraisal, Change Management.

Operations Management: Evolution of Manufacturing and Production Strategies, Production Planning and Control (PPC) Functions, Quantitative Methods Applied in Production, Location Planning, Layout Planning and Safety Management, Concurrent Engineering, JIT Production, Mass Production, Mass Customization, Lean Manufacturing, Reverse Engineering, Reengineering, Recycling and Refurbishment, Inventory Management, Value Chain Management and Supply Chain Management, Horizontal and Vertical Integration, Economies of Scale and Economies of Scope, Comparative Advantage, Competitive Advantage.

Quality Management: Quality Concept, Quality Assurance, Quality Control, Cost of Quality, Traditional and Taguchi Quality Loss Function, Six Sigma and Kaizen Quality Control System.

Cost and Financial Management: Elements of Cost Products, Cost Analysis, Investment Analysis, and Benefit Cost Analysis, Risk Analysis.

Management Accounting: Cost Planning and Control, Budget and Budgetary Control.

Marketing Management: Different Philosophy of Marketing, Marketing Mix, Sales Promotion, Advertisement, Lead Generation.

Technology Management: Management of Innovation, Technology Assessment, Technology Prediction and Technology Forecasting, Technology Life Cycle, Intellectual Property.

Knowledge Management: Concept of Knowledge, Organizational Knowledge, Explicit and Tacit Knowledge, Organizational Knowledge Management System.

References:

1. Lean Production Simplified, 2nd Edition, Pascal Dennis, CRC Press.
2. Industrial Management, 1st Edition, D K Bhattacharyya, Martino Fine Book.

EEE 3104	**Microprocessor and Interfacing Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 3103**

EEE 3106	**Communication Systems Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 3105**

3rd Year 2nd Semester

EEE 3201	**Power System I**	**3 Credits, 3 Hours/Week**

Overview of Modern Power Systems: Generations, Transmissions and Distributions.

Power System Analysis: Phasors, Voltage-Current-Power Relationships in Single/ Three-Phase Systems, Complex Power, Power Triangle, Direction of Power Flow.

Representation of Power Systems: Single-Line Diagram, Per-Unit Methodology.

Modelling Circuit of Power System Components: Transformers, Generators, Loads, Current-Voltage Relationships on Transmission Line: Representation of Lines, Short Transmission Line, Medium-Length Line, Long Transmission Line, Power Flow through a Transmission Line.

Steady-State and Dynamic Behaviour of Power Systems.

Network Matrices and Power Flow Analysis: Network Matrices, Power Flow Problem, Gauss- Seidel Method, Newton-Raphson Method, Power Flow Studies in System Design and Operation.

Power System Fault Calculations: Symmetrical Components, Symmetrical Faults: Transients in RL Series Circuits, Internal Voltages of Loaded Machines, Under Fault Conditions, Fault Calculations using Z-Bus, Unsymmetrical Faults: Unsymmetrical Faults on Power System, Single Line-to-Ground Faults, Double Line-to-Ground Faults, Open-Conductor Faults, Surge Propagation.

Operation of Power Systems: Distribution of Load between Units within a Plant, Distribution of Load between Plants, Transmission-Loss Equation, Dispatch with Losses.

Basic Principles on Power System Protection and Control.

References:

1. Power System Analysis by John J. Grainger and William D. Stevenson, McGraw Hill.
2. Elements of Power System Analysis, William D. Stevenson, McGraw-Hill.
3. Power System Analysis, 3rd Edition, Hadi Saadat, PSA Publication.
4. Modern Power System Analysis, 4th Edition, D P Kothari and I J Nagrath, Tata McGraw Hill Education.
5. Power Systems Analysis, T.K. Nagsarkar and M.S. Sukhija, Oxford University Press.
6. Electric Power Engineering Handbook, Leonard L. Grigsby, CRC Press.
7. Modern Power System Analysis, 2nd Edition, Toran Gonen, CRC Press.
8. Electric Power Principles: Sources, Conversion, Distribution and Use, 1st Edition, James L. Kirtle, Wiley.
9. Power System Analysis and Design, 6th Edition, J. Duncan Glover, Thomas Overbye and Mulukutla S. Sarma, Cengage Learning.
10. Power Systems Analysis, 2nd Edition, Arthur R. Bergen and Vijay Vittal, Pearson.

EEE 3203	**Digital Signal Processing**	**3 Credits, 3 Hours/Week**

Introduction: Basic Elements, Advantages and Application Areas of Digital Signal Processing (DSP), Sampling Theorem, Sampling and Quantization of Continuous-Time Signals, Analysis of Finite Word-Length Effects, Overview of Discrete-Time Signals and Systems, Hardware Implementation of Discrete-Time LTI System, Correlation and its Applications in DSP.

Fourier Analysis of Discrete-Time Signals and Systems: Frequency Domain Sampling and Reconstruction of Discrete-Time Signals, The Discrete-Time Fourier Transform, Frequency Resolution of DFT, Properties of DFT, Linear and Circular Convolution using DFT, Frequency Analysis of Signals using the DFT.

Fast Fourier Transform (FFT): Computational Complexity of Direct DFT, FFT Algorithms, Decimation-in-Time FFT, Decimation-in-Frequency FFT, Computational Advantages of FFT, Applications of FFT in Linear Filtering and Correlation, Quantization Effects in the Computation of FFT.

The Z-Transform: The Z-Transform, Properties of Z-Transform, Rational Z-Transform and Time-Domain Behaviour of LTI System, Inverse Z-Transform, One-Sided Z-Transform, Solution of Difference Equations, Analysis of LTI

Systems in the Z-Domain, Causality and Stability of LTI System in Z-Domain, Frequency Response of LTI System.

Digital Filter Design: Structures of FIR and IIR Filters, Design of FIR Filters using: Windows Method, Frequency Sampling Method, and Chebyshev Approximation Method, Finite Word-Length Effect in FIR Filter, Design of IIR Filters: Impulse Variant Method, Bilinear Z-Transform Method, Derivatives Approximation Method, Least-Squares Method.

Adaptive Filter: Concepts of Adaptive Filter, Components of Adaptive Filter, Basic Wiener Filter Theory, LMS Adaptive Algorithm, Recursive Least Squares Algorithm.

References:

1. Digital Signal Processing-Principles, Algorithms and Applications, 3rd Edition, John G. Proakis and Dimitris G. Manolakis, Prentice-Hall International, Inc.
2. Digital Signal Processing-A Practical Approach, 3rd Edition, Emmanuel C. Efeacher and Barrie W. Jervis, Prentice-Hall
3. Digital Signal Processing-A Computer based Approach, 3rd Edition, Sanjit K. Mitra, Mc-Graw Hill.
4. Discrete-Time Signal Processing, 2nd Edition, Alan V. Oppenheim, Alan W. Schafer and John R. Buck, Prentice-Hall.

EEE 3205	**Materials Science**	**3 Credits, 3 Hours/Week**

Thermal Properties: Specific Heat of Solid- Dulong-Petit Law, Boltzmann, Einstein and Debye Models of Specific Heat, Thermal Expansion of Solid, Effect of Non-Harmonic Potential, Heat Conduction by Phonons, Thermal Conductivity of Materials, Thermionic Emission.

Electrical Properties: The Drude Theory of Metal, Classical DC and AC Electrical Conductivity, Hall Effect and Magnetoresistance, Quantum Mechanical Corrections to Electrical Conductivity.

Dielectric Properties: Macroscopic Maxwell's Equation, Theory of Local Field, Clausius-Mossotti Equation, Dielectric Constant and Polarizability, Ferro-electric, Anti-ferroelectric, Piezoelectric Materials.

Optical Properties: Optical Processes, Optical Coefficients, The Complex Refractive Index and Dielectric Constant, The Lorentz Dipole Oscillator Model, Excitons and its Binding Energy, Interband Luminescence, Photo Luminescence, Electroluminescence.

Magnetic Properties: Magnetic Moments and Angular Momentum, The Bohr Magneton, Magnetic Susceptibility, Classical Diamagnetism, Langevin Paramagnetism, Ferrimagnetism, Ferromagnetism and Antiferromagnetism.

Superconductivity: Superconducting Material, Zero Resistivity, The Meissner-Ochsenfeld Effect, Perfect Diamagnetism, Type I and Type II Superconductivity, The London Equation.

Nonlinear Optics: Nonlinear Optical Processes, Nonlinear Susceptibility, Anharmonic Oscillator, Phase Matching, Sum and Difference Frequency Generation, Second Harmonic Generation.

References:

1. Solid State Physics, 1st Edition, Neil W. Ashcroft and N. David Mermin, Cengage Learning.
2. The Oxford Solid State Basics, 1st Edition, Steven H. Simon, Oxford University Press.
3. Introduction to Solid State Physics, 8th Edition, Charles Kittel, Wiley.
4. Electronic Properties of Materials 4th Edition, Rolf E. Hummel, Springer.
5. Optical Properties of Solids, 2nd Edition, Mark Fox, Oxford University Press.
6. Magnetism in Condensed Matter Paperback, Stephen Blundell, Oxford University Press.
7. Superconductivity, Superfluids, and Condensates, 1st Edition, James F. Annett, Oxford University Press.
8. Nonlinear Optics, 3rd Edition, Robert W. Boyd, Academic Press.

EEE 3207	**Optoelectronics and Photonics**	**3 Credits, 3 Hours/Week**

Nature and Properties of Light: Optical Spectra of Atoms, Molecules, and Solids, Refractive Index, Negative Refractive Index of Metamaterials, Quantum Nature of Light and Matter, Light Matter Interaction at Nanoscale, Diffraction of Light, Wave Optics and Gaussian Beams.

Optical Properties in Semiconductor and LED: Direct and Indirect Band-Gap Materials, Radiative and Non-Radiative Recombination, Optical Absorption, Photo-Generated Excess Carriers, Minority Carrier Lifetime, Luminescence and Quantum Efficiency in Radiation, Principles of LED, Materials for LED, Internal and External Efficiency, Loss Mechanism, Structure and Coupling to Optical Fibers, White LED Technologies.

Semiconductor Lasers: Spontaneous and Stimulated Emission, Einstein Relations, Gas Lasers and Applications, Theory of Laser Oscillation, Characteristics of Laser Output, Hetero-Junction Lasers, Introduction to Quantum Well Lasers, Single Frequency Solid State Lasers, VCSELs.

Photo-Detectors: PN Junction Photodiode, PIN Photodiode, Avalanche Photodiodes, Heterojunction Photodiodes and Phototransistors.

Solar Cells: Solar Energy and Spectrum, Photovoltaic Device Principles, I-V Characteristics, Equivalent Circuit, Thin Film Solar Cell, Solar Cells Materials, Devices and Efficiencies, Heterojunction Solar Cell, Tandem Solar Cell.

Introduction to Photonics: Ring Resonators, Optical Couplers, Photonic Crystal and Guided Optics, Silicon Photonics, Basic Principles of Holography.

References:

1. Optoelectronics & Photonics: Principles & Practices, 2nd Edition, S. O. Kasap, Pearson.
2. Fundamentals of Photonics, 2nd Edition, B. E. A. Saleh and M. C. Teich, John Wiley and Sons.
3. Optics, E. Hecht and A. Zajac, 3rd Edition, Addison-Wesley.
4. Light-Matter Interaction: Physics and Engineering at the Nanoscale, 2nd Edition, John Weiner, Oxford University Press.
5. Nanoscale Photonics and Optoelectronics, Zhiming M. Wang and Arup Neogi, Springer.

EEE 3209	**Communication Theory**	**3 Credits, 3 Hours/Week**

Spectral Analysis: Fourier Series, The Sampling Function, Response of a Linear System, Normalized Power, Normalized Power in a Fourier Expansion, Power Spectral Density, The Fourier Transform, Convolution, Parseval's Theorem, Correlation between Waveforms, Autocorrelation.

Random Variables and Processes: Probability, Cumulative Distribution Function, Probability Density Function, Tchebycheff's Inequality, The Gaussian Probability Density, The Error Function, The Rayleigh Probability Density, Correlation Between Random Variables, The Central-Limit Theorem, Random Processes, Autocorrelation, Power Spectral Density of a Sequence of Random Pulses, Power Spectral Density of Digital Data, Effect of Rudimentary Filters on Digital Data, The Complimentary Error Function.

Mathematical Representation of Noise: Some Sources of Noise, A Frequency-Domain Representation of Noise, Spectral Components of Noise, Response of a Narrowband Filter to Noise, Effect of a Filter on the Power Spectral Density of Noise, Superposition of Noises, Mixing Involving Noise, Linear Filtering, Noise Bandwidth, Quadrate Components of Noise, Power Spectral Density of $N_C(T)$ and $N_S(T)$, Probability Density of $N_C(T)$ and $N_S(T)$, and their Time Derivatives.

Communication System and Noise Calculations: Resistor Noise, Multiple Resistor Noise Sources, Networks with Reactive Elements, Available Power, Noise Temperature, Two Ports, Noise Bandwidth, Effective Input-Noise Temperature,

Noise Figure, Noise Figure and Equivalent Noise Temperature of a Cascade, Example of a Receiving System, Antennas, System Calculation.

Information Theory: Discrete Message, The Concept of Amount of Information, Average Information, Entropy, Information Rate, Coding to Increase Average Information per Bit, Mutual Information, Shannon's Theorem, Channel Capacity, Capacity of a Gaussian Channel, Bandwidth-S/N Trade-off, Use of Orthogonal Signals to Attain Shannon's Limit, Efficiency of Orthogonal Signal Transmission.

Baseband Digital Transmission: Limitations, Pulse Shaping, Repeaters, Inter Symbol Interference (ISI), Pulse Equalization Techniques, Nyquist Criterion for Zero ISI, Delay in Detection, Fixed Equalizer, Design of Equalizer, Adaptive Equalizer, AWGN Channel Model, Bit Error Rate of a Baseband Transmission System, Channel Capacity Theorem, Coherent Reception, Digital Receivers, Matched Filter and Correlation Receiver, Bit Error Rate Calculation of a Digital Link, Digital Link Design.

Wireless Digital Communication System: Wireless Channel Model, Noncellular and Cellular Communication, Cellular Concept, Frequency Reuse Techniques, and Introduction to Mobile Communication Systems.

References:

1. Probability and Random Processes, Geoffrey Grimmett and David Stirzaker, Oxford University Press.
2. Probability, Random Processes, and Estimation Theory for Engineers, Stark &Woods, Prentice Hall.
3. Probability, Statistics, and Random Processes for Electrical Engineering, Leon-Garcia, Addison-Wesley.
4. Elements of Information Theory, T M Cover & J A Thomas, Wiley.
5. Signal Processing and Detection, John Cioffi.
6. Modulation and Coding for Wireless Communications, Burr A, Prentice Hall.
7. Digital Communications Fundamentals and Applications, Sklar B, Prentice Hall.
8. Digital Communications, I. A. Glover & P.M. Grant, Prentice Hall.
9. Introduction to Digital Communications, R.E. Ziemer & R.L. Peterson, MacMillan.
10. Wireless Communications, Andre Goldsmith, Cambridge University Press.
11. Communication Systems, 4th Edition, Simon Haykin, Wiley.
12. Digital Communications Systems, 1st Edition, Simon Haykin, Wiley.
13. Wireless Communications: Principles and Practice, 2nd Edition, Theodore S. Rappaport, Prentice Hall.
14. Communication Systems Engineering, 2nd Edition, John G. Proakis and Masoud Salehi, Pearson.
15. Probability, Random Variables and Stochastic Processes, 4th Edition, Athanasios Papoulis and S. Unnikrishna Pillai, McGraw-Hill Europe.

16. Principles of Communications: Systems, Modulation, and Noise, 4th Edition, Rodger E. Ziemer and W. H. Tranter, Wiley.
17. Modern Digital and Analog Communication Systems, 4th Edition, B.P. Lathi, Zhi Ding and Hari Mohan Gupta, Oxford University Press.
18. Principles of Communication Systems, 4th Edition, Herbert Taub, Donald Schilling and Goutam Saha, McGraw-Hill Education.

GED 3201	Financial Accounting and Cost Management	3 Credits, 3 Hours/Week

Financial Accounting: Objectives and Importance of Accounting, Purpose of Accounting, Branches of Accounting, Accounting as an Information System, Accounting standards GAAP, Need for Integrity in the field of Accounting, Double Entry Mechanism, Accounts and their Classification, Basic Accounting Equation, Accounting Cycle, Journal, Ledger, Trial Balance, Need for Financial Statement, Four Basic Financial Statements: Income Statement, Cash Flow, Balance Sheet, Stake Holders Equity, Preparation of Financial Statements, Financial Statements Analysis and Interpretation: Horizontal and Vertical Analysis, Ratio Analysis: Calculation of Different Financial Ratios and their Significance, Project Financing, Financial Market, Financial Instruments.

Cost and Management Accounting: Introduction to Cost and Management Accounting**,** Objectives and Scope of Cost and Management Accounting**,** Functions of Management Accounting, Relationship of Cost Accounting, Financial Accounting, Management Accounting and Financial Management, Limitations of Financial Accounting, Cost Concept and Classification, Cost Segregation, Methods of Cost Segregation: Two-Point Method, Least Square Method, Cost Estimation, Accounting for Materials, Accounting for Labour Cost, Accounting for Overhead Cost, Costing in Different Situations: Service Costing, Job Order Costing, Process Costing, Joint Product and By-Product Costing, Accounting for Profit Planning: Absorption Costing, Variable Costing, Reconciliation of Profit/Loss, Cost–Volume Profit Analysis, Cost Accounting for Planning and Control: Standard Costing, Variance Analysis, Budgeting for Planning, Flexible Budgeting, Cost Reduction: Cost Reduction and Cost Control, Value Engineering, Value Analysis.

Decisions: Relevant and Differential Cost Analysis, Linear Programming, Long-Term Investment Decisions: Capital Budgeting, Various Techniques of Evaluation of Capital Investment, Investment Appraisal under Uncertainty, Risk Management, Capital Rationing, Working Capital Management, Fund Flow Statement and Sources and Uses of Funds, Cash Flow Statement and Management of Cash, Stock Debtors, Management of Profits/Dividend Policy.

References:

1. Cost Accounting, 3rd Edition, Ralph S. Polimeni, Frank Fabozzi and Arthur H. Adelherg, McGraw Hill.
2. Managerial Accounting, 10th Edition, R.H. Garrison, McGraw Hill.
3. Financial Accounting, Wyane Thomas, 4th Edition, McGraw-Hill Education.

EEE 3202	**Power System I Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 3201**

EEE 3204	**Digital Signal Processing Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 2109** and **EEE 3203**

EEE 3212	**Electrical Services Design and Drafting**	**1.5 Credits, 3 Hours/Week**

4th Year 1st Semester

EEE 4101	**Power Electronics and Industrial Automation**	**3 Credits, 3 Hours/Week**

Introduction: Types of Power Electronic Circuits, Determining the Root-Mean-Square Values of Waveforms, Characteristics and Specifications of Switches, Power Semiconductor Devices, Device Choices, Power Diodes and Switches.

RLC Circuits: Diode Characteristics, Reverse Recovery Characteristics, Diode Switched RC Load, Diode Switched RL Load, Diode Switched LC Load, Freewheeling Diodes with Switched RL Load, Recovery of Trapped Energy with a Diode.

Diode Rectifiers: Performance Parameters, Single-Phase Full-Wave Rectifiers, Single-Phase Full-Wave Rectifier with a Highly Inductive Load, Three-Phase Bridge Rectifiers.

DC–DC Converters: Performance Parameters of DC–DC Converters, Principle of Step-Down Operation, Principle of Step-Up Operation, Converter Classification, Switching-Mode Regulators, Buck Regulators, Boost Regulators, Buck–Boost Regulators.

DC–AC Converters: Performance Parameters, Principle of Operation, Single-Phase Bridge Inverters, Three-Phase Inverters.

Thyristors: Two-Transistor Model of Thyristor, Thyristor Turn-On, Thyristor Turn-Off, Thyristor Types, di/dt Protection, dv/dt Protection, Thyristor Firing Circuits.

Industrial Motor Drives: Basic Characteristics of DC Motors, Operating Modes, Single-Phase Drives, Three-Phase Drives, DC–DC Converter Drives, Stepper Motor Control, Microcomputer Control of DC Drives.

PLC and HMI for Industrial Automation: Controllers, Hardware, Internal Architecture, Programming, Testing and Debugging, HMI Development and Programming.

References:

1. Power Electronics, 1st Edition, Daniel W Hart, McGraw-Hill Education.
2. Power Electronics: Circuits, Devices & Applications, 4th Edition, Muhammad H. Rashid, Pearson.
3. Power Semiconductor Circuits, S. B. Dewan and A. Straughen, Wiley.
4. Power Electronics: Converters, Applications, and Design, 3rd Edition, Ned Mohan, Tore M. Undeland and William P. Robbins, Wiley.
5. Fundamentals of Power Electronics, 2nd Edition, Robert W. Erickson and Dragan Maksimovic, Springer.
6. Pulse-Width Modulated DC-DC Power Converters, 1st Edition, Marian K. Kazimierczuk, Wiley.

GED 4101	**Professional Ethics**	**3 Credits, 3 Hours/Week**

Introduction to Profession: Definition of a Profession, Characteristics of a Profession, Concept of Professional Engineer, Boundary Line Profession and Semi Profession.

Introduction to Philosophy: Different Branches of Philosophy, Philosophical Methods: Epistemology, Ontology, Axiology, Inductive and Deductive Reasoning, Definition and Scope of Ethics, Ethics as a Branch of Philosophy.

Different Sources of Ethics: Different Branches of Ethics: Meta Ethics, Normative Ethics, Applied Ethics, Different Framework of Ethics: Deontological, Teleological and Virtue Ethics, Moral Agent, Ethical Community, Moral Imagination and Ethical Compass, Different Methods of Ethical Decision Making, Moral Psychology, Ethical Relativism, Factors of Limited Ethicality, Evolution of Ethics as a Discipline, History and Development of Engineering Ethics, History of Engineering Education in Pre and Post Industrial Revolution and Development of Engineering Ethics, Development of Engineering Professional Bodies and Enforcement of Code of Conduct, Characteristics of a Professional Code.

Obligation of an Engineer: Prohibitive, Preventive and Aspirational Ethics, Micro, Meso and Macro Ethics, Avoidance of Conflict of Interest, Whistleblowing, Fiduciary Duty, Improvement of the Quality of Engineering Profession, Environmental Ethics, Information and Computer Ethics, Financial and Business Ethics.

Law and Ethics: Different Laws Concerning Engineering Practice, Breach of Trust, Inevitable Disclosure Doctrine, and System of Justice Delivery in Bangladesh.

Reference:

1. Engineering Ethics, 4th Edition, Charles B Fleddermann, Pearson.

EEE 4131	Device Fabrication Techniques	3 Credits, 3 Hours/Week

Crystal Structure: Silicon as Indirect Band Gap Material, Crystal Structure and its Property, GaN, GaAs as Direct Band Gap Materials, Crystal Structure and their Properties, Miller-Bravis Indices, Weber Symbol, Zone Axis Symbol, Reciprocal Lattice, Hexagonal and Cubic Closest Packings, Body Centered Cubic Packing, Voids in Closest Packings and Body Centered Cubic Packing.

Crystal Growth Technology: Phase Diagram and Solid Solubility, Metallurgical and Electronic Grade of Growth, Purification of Grown Crystals, Czhorkralski Method, Float-Zone Method, Wafer Preparation and Specifications, Shaping of Wafers, Solution Growth, Sol-Gel Method.

Epitaxial Growth: Epitaxy, Gas Kinetics, Vapor Phase Epitaxy (VPE), Molecular Beam Epitaxy (MBE), Metal Organic Chemical Vapor Deposition (MOCVD), Organo Metallic Vapor Phase Epitaxy, HVPE, Plasma-Assisted CVD, Chemical Beam Epitaxy, Atomic Layer Deposition, Different Growth Processes of Si Epitaxy: Their Advantages and Disadvantages, Doping During Epitaxy, Auto-Doping and its Effect- Junction Shift, Pattern Shift and Distortion, In-situ Cleaning for Si Epitaxy and its Necessities, Defects in Epitaxial Layer: Stacking Fault, Misfit and Threading Dislocation and their Origin, Dislocation Types, Technique to Identify Types of Dislocation.

Deposition of Dielectric Layers: Thermal Oxidation: Deal and Grove Model, Wet and Dry Oxidation Process, Silicon Nitride Growth.

Lithography: Mask for Lithography, Photo-Resist Materials, Positive and Negative Photolithography, E-Beam and X-Ray Lithography, Extreme UV (EUV) Lithography, Pros and Cons of Different Lithography Techniques.

Etching: Etch Parameters, Wet Etching, Dry Etching: Plasma Etching, Ion Beam Etching, Sputtering Etching and Reactive Ion Etching, Lift-Off Techniques, Stripping of Resist Materials, Self-Aligned Double Patterning (SADP) and Self-Aligned Quadruple Patterning (SAQP).

Diffusion and Ion Implantation: Theory of Diffusion, Infinite and Finite Diffusion Processes, Ion Implantation Processes, Doping Profile for Diffusion and Ion Implantation Systems.

Metallization: Types of Metals, Metal Deposition Systems: Evaporation, Sputtering, Metal CVD, Copper Electroplating.

Gas Control in Process Chambers: Vacuum Ranges, Vacuum Pumps: Roughing Pump, High Vacuum Pump, Mass Flow Controller, Residual Gas Analyzer, Plasma: Glow Discharge, Radicals.

Clean Room: Contamination Control, Impurities Control, Classification of Clean Room, Design Strategy and Construction of Clean Room.

Assembly and Packaging: Backgrind by Chemical Mechanical Polishing, Die Separation: Scribing, Cleaning and Inspection, Die Attach, Wire-Bonding, IC Packaging.

References:

1. The Basics of Crystallography and Diffraction, Christopher Hammond, 2nd Edition, Oxford University Press.
2. Electronic Processes in Materials, Leonid V. Azaroff and James J. Brophy, McGraw-Hill Book Company.
3. Semiconductor Manufacturing Technology, 1st Edition, Michael Quirk and Julian Serda, Prentice-Hall.
4. VLSI Fabrication Principles Silicon and Gallium Arsenide, 2nd Edition, Sorob K. Ghandi; John Wiley and Sons. Inc.
5. Lecture Series on VLSI Design by Dr. Nandita Dasgupta, Department of Electrical Engineering, IIT Madras.
6. Silicon Processing for the VLSI Era, Vol I, II, and III, S. Wolf and R. N. Tauber, Lattice Press.
7. Microchip Fabrication: A Practical Guide to Semiconductor Processing, 6th Edition, Peter Van Zant, McGraw-Hill Education.
8. Fabrication Engineering at the Micro- and Nanoscale, 4th Edition, Stephen A. Campbell, Oxford University Press.
9. The Science and Engineering of Microelectronic Fabrication, 2nd Edition, Stephen A. Campbell, Oxford University Press.

EEE 4133	**VLSI Circuit Design**	**3 Credits, 3 Hours/Week**

CMOS Circuits: VLSI Design Flow, MOS Transistor, CMOS Logic, Circuit Representation, nMOS and pMOS Transistors, MOS Transistor Design, CMOS Inverter, NAND, NOR, Complex CMOS Gates, XOR, Transmission Gates (TGs).

MOS Transistor Theory: MOS Transistor Theory, Enhancement pMOS and nMOS devices, MOS Device Design Equations, MOSFET RC Model and CMOS Capacitances, DC Characteristics and Transient Analysis of a CMOS Inverter.

CMOS Processing Technology: CMOS Process Flow, CMOS Fabrication, CMOS Layers and Gate Layout, Complex Gate Layout, Stick Diagrams, Layout Design Rules, Latchup.

Circuit Characterization and Performance Evaluation: Delay Estimation, Logical Effort, Inverter Speed and Power Dissipation, Interconnects, Transistor Sizing.

CMOS Logic and Design: Physical Design of Logic Gates, CMOS Logic Structures, Layout Techniques, Hierarchical Design, Differential and Dynamic Logic, I/O Structures, Clock, Design Methods, Design Strategies, Design Options-Gate Arrays, Gate Design/Analysis, Multi-Cell Layout, Inter-Cell Routing, Submicron Design, Advanced Design Tools- Capture and Verification.

Subsystem Design: Adders, Comparators, Multipliers, Latches and Flip Flops, Tri-States, C2MOS, Multiplexers, Decoders, Shifters, Memory Basics, SRAM Cells and Arrays, Programmable Logic Arrays (PLAs), Data Path and Control Unit, Register File, Arithmetic Logic Unit (ALU).

References:

1. CMOS VLSI Design, 3rd Edition, Neil Weste and David Harris, Addison Wesley.
2. Digital Integrated Circuit Design, K. Martin, Oxford University Press.
3. CMOS Circuit Design, Layout, and Simulation, R. Jacob Baker, Harry W. Li and David E. Boyce, Wiley-IEEE Press.

EEE 4141	**Telecommunication Engineering**	**3 Credits, 3 Hours/Week**

Introduction: Basic Concept of Electricity for Communication, Electrical Signals, Transmission of Electrical Signals – Wire Pair, Co-Axial Cable, Optical Fiber Cable, Radio Transmission, Voice and Data Transmission, Impairments to Voice Transmission-Amplitude Distortion, Phase Distortion, Noise, Simple Telephone Communication, Subscriber's Line Circuit, Two-Wire and Four-Wire Transmission, Multiplexing Techniques- TDM and FDM, Digital Signal Hierarchies in Telephone Systems – DS0, DS1, DS3, E1, E2, E3.

Switching Systems: Basic Switching System, Conventional Analog Switching, Types of Electromechanical Switches – Strowger and Crossbar Switch, Principles of Common Control, Touch Tone Dial Telephone, Crosspoint Technology, No. 1 ESS, Japanese D-10, Metaconta.

Signal Switching: Stored Program Control, Centralized SPC, Distributed SPC, Software Architecture, Application Software, Enhanced Services, Two-Stage

Network, Three-Stage Network, N-Stage Network, Concepts of TDM, Basic Time Division Space Switching, Basic Time Division Time Switching, Time Multiplexed Space Switching, Time-Multiplexed Time Switching, Combination Switching, Three-Stage Combination Switching, N-Stage Combination Switching.

Speech Digitization and Transmission: Sampling, Quantization, Companding, Vocoders, Speech Model used in Vocoder Design.

Traffic Engineering: Traffic Characterization, Traffic Load, Loss Systems & Delay Systems, Grade of Service (GoS), Blocking Probability, Call Congestion and Time Congestion, Traffic Intensity, Modelling Switching Systems- Markov Processes and Birth-Death Processes, Blocking Models and Loss Estimates, Erlang B and C Formula, Quality of Service (QoS).

Telephone Networks: Subscriber Loop Systems, Switching Hierarchy and Routing, Transmission Plan, Transmission Systems, Numbering Plan, Charging Plan, Signalling Techniques, In-channel Signalling, Common Channel Signalling.

CCITT Signalling System No. 7 (SS7): Overview of SS7 Architecture, Relationship to OSI, Layer 1, 2 and 3, Signalling Network Structure, Signalling Performance, Numbering Plan, Signalling Connection Control Part (SCCP), User Part.

Integrated Services Digital Network (ISDN): N-ISDN and B-ISDN, Architecture of ISDN, B-ISDN Implementation.

Access Network Technologies: Digital Subscriber Loop (DSL), Wireless Local Loop (WLL), Hybrid Fiber Coax (HFC), Fiber to the X (FTTX), Ethernet Passive Optical Network (EPON), Gigabit PON (GPON).

Overview of IP Telephony, VoIP and Next Generation Network (NGN).

References:

1. Digital Telephony, John C. Bellamy, Wiley Interscience.
2. Data Communications & Networking, Behrouz A. Forouzan, TATA McGraw-Hill.
3. Communication Networks, Alberto Leon-Garcia & Indra Widjaja, McGraw-Hill.
4. Voice over IP Technologies, Mark A. Miller, Wiley-Dreamtech.
5. Queueing Systems, Volume 1: Theory, Leonard Kleinrock, John Wiley & Sons.
6. Introduction to Queueing Theory, R.B. Cooper, Macmillan Press.
7. Telecommunication Networks: Devices, Circuits, and Systems, 1st Edition, Eugenio Iannone, CRC Press.
8. Telecommunication Switching Systems and Networks, Thiagarajan Viswanathan and Manav Bhatnagar, Prentice Hall.
9. Signaling in Telecommunication Networks, 2nd Edition, John G. van Bosse and Fabrizio U. Devetak, Wiley-Interscience.
10. Telecommunication Switching, Traffic and Networks, J. E. Flood, Pearson.

EEE 4143	Optical Fiber Communication Systems and Networks	3 Credits, 3 Hours/Week

Introduction: Optical Fibers, Structures, Step-Index and Graded-Index Fibers, Modes of Propagation, Modal Theory for Circular Waveguide, Modal Equations, Waveguide Equations, Power Flow in Optical Fibers, Fiber Materials, Mechanical Properties of Glass Fiber, Optical Fiber Cables.

Transmission Characteristics: Signal Degradation in Optical Fibers, Fiber Attenuation, Power Independent and Power Dependent Losses, Distortion in Optical Guides, Dispersions-Intermodal and Intramodal, Material and Waveguide Dispersion, Dispersion Compensating Fiber, Mode Coupling.

Optical Sources: Light Emitting Diode (LED) and Semiconductor Laser Diode (SLD), Structures, Emission Patterns and Spectral Width, Modulation Capability, Transient Response, Power Bandwidth Product, Modal Noise, Temperature Effects and Reliability, Single and Multi-Longitudinal Mode Laser Diodes.

Optical Detectors: PIN and Avalanche Photodetectors, Structures, Principles of Operations, Efficiency and Responsivity, Response Time, Photodetector Noise, Photodiode Materials.

Optical Components: Connectors, Couplers, Splicer, Isolators, Circulators, Filters: Thin Film Filters, Array Waveguide Gratings, Fiber Bragg Gratings, Optical Amplifiers: Semiconductor Optical Amplifier (SOA), Erbium-Doped Fiber Amplifier (EDFA), EDFA Construction and Principle, Multi-Stage EDFA.

Optical Modulator and Receiver: Optical Modulation-Direct and External, Mach-Zehnder Modulator, Direct and Coherent Detection Receivers: Configuration, Operation, Noise Sources, Bit-Error-Rate and Sensitivity Calculation, Design of Analog and Digital Receivers.

Optical Networks: Link Power Budget, Fiber Link Design, Power and Dispersion Penalty, Wavelength Division Multiplexing (WDM), Dense Wavelength Division Multiplexing (DWDM) and Optical Frequency Division Multiplexing (OFDM) Transmission Schemes, Optical Data Coding, Optical Data Buses, Optical Networks, Fiber Distributed Data Interface (FDDI) and Synchronous Optical Network (SONET)/SDH.

References:

1. Optical Fiber Communications: Principles and Practice, 3rd Edition, John M. Senior, Pearson Education.
2. Optical Fiber Communications, 3rd Edition, Gerd Keiser, McGraw-Hill Higher Education.
3. Fiber-Optic Communication Systems, 3rd Edition, Govind P. Agrawal, John Wiley & Sons.
4. An Introduction to Fiber Optic Systems, 2nd Edition, John Powers, McGraw-Hill International Editions.

EEE 4151	Power System II	3 Credits, 3 Hours/Week

Power Transmission/Distribution Paths: Overhead Transmission Lines, Underground/Underwater Cables, and their Mechanical Designs.

Modelling of Machines: Two Axes Model of Machines, Load Capability of Generators (Conventional and Renewable Based).

Power System Stability: Overview on Steady-State and Dynamic Behaviour of Power Systems, Classification of Stability, Rotor Angle Stability- Swing Equation, Power Angle Equation, Equal Area Criterion, Multi-Machine System, Factors Affecting Stability.

Voltage Stability: Basic Concepts Related to Voltage Stability, Voltage Collapse Phenomena, Static Analysis of Voltage Stability-V/Q Sensitivity Analysis, Q/V Modal Analysis.

Flexible AC Transmission System (FACTS): Introduction, SVC, STATCOM, SSSC, TCSC, TCSR, TCPST, UPFC, IPFC, DVR.

High Voltage DC (HVDC) Transmission System: Types of HVDC, Its Components and Operations.

Power Quality: Voltage Sag/Swell, Harmonics, Surges, Inter-Harmonics, Flicker, Grounding Problems, Mitigation Techniques, Power Quality Standards.

References:

1. Power System Analysis by John J. Grainger and William D. Stevenson, McGraw Hill.
2. Elements of Power System Analysis, William D. Stevenson, McGraw-Hill.
3. High Voltage Engineering Fundamentals, 2nd Edition, by John Kuffel and Peter Kuffel, Newnes.
4. Power System Stability and Control, 1st Edition, Prabha Kundur, McGraw Hill.
5. Modern Power System Analysis, 2nd Edition, Toran Gonen, CRC Press.
6. Electric Power Engineering Handbook, Leonard L. Grigsby, CRC Press.
7. HVDC and FACTS Controllers, Vijay K. Sood, Springer.
8. High Voltage Engineering, 1st Edition, Farouk A.M. Rizk and Giao N. Trinh, CRC Press.
9. High Voltage Direct Current Transmission: Converters, Systems and DC Grids, 1st Edition, Dragan Jovcic and Khaled Ahmed, Wiley.
10. Power Systems Analysis, T.K. Nagsarkar and M.S. Sukhija, Oxford University Press.
11. Power System Analysis and Design, 6th Edition, J. Duncan Glover, Thomas Overbye and Mulukutla S. Sarma, Cengage Learning.
12. Power Systems Analysis, 2nd Edition, Arthur R. Bergen and Vijay Vittal, Pearson.

EEE 4153	Power System Protection	3 Credits, 3 Hours/Week

Introduction: Purpose of Power System Protection, Criteria for Detecting Faults: Over Current, Differential Current, Difference of Phase Angles, Over and Under Voltages, Power Direction, Symmetrical Components of Current and Voltages, Impedance, Frequency and Temperature, Instrument Transformers: CT and PT.

Electromechanical, Electronic and Digital Relays: Basic Modules, Over Current Relays, Distance Relays, Directional Relays, Inverse Definite Minimum Time (IDMT) Relays, Differential and Percentage Differential Relays, Pilot Relays, Wire Pilot Carrier, Trip Circuits.

Unit Protection Schemes: Generator, Transformer, Motor, Bus Bar, Transmission and Distribution Lines, HVDC System and Feeders.

Circuit Breakers: Principle of Arc Extinction, Transient Recovery Voltage, Selection Criteria and Ratings of Circuit Breakers, Types - Miniature Circuit Breaker (MCB), Molded Case Circuit Breaker (MCCB), Air Circuit Breaker (ACB), Air Blast Circuit Breaker (ABCB), Vacuum Circuit Breaker (VCB), Oil Circuit Breaker (OCB), Minimum Oil Circuit Breaker (MOCB) and Sulfur Hexafluoride (SF6) Circuit Breaker.

References:

1. Power System Protection, 1st Edition, Paul M. Anderson, Wiley and IEEE Press.
2. Protection of Industrial Power Systems, 2nd Edition, T. Davies, Elsevier.
3. Fundamentals of Power System Protection, Y.G. Paithankar and S.R. Bhide, Prentice Hall.
4. Practical Power Systems Protection, Les Hewitson, Mark Brown Senior Staff Engineer and Ben Ramesh, Elsevier.
5. Protective Relaying: Principles and Applications, 4th Edition, J. Lewis Blackburn and Thomas J. Domin, CRC Press.
6. Power System Protective Relaying, 1st Edition, J C Das, CRC Press.

EEE 4161	Computer Organization and Architecture	3 Credits, 3 Hours/Week

Computer System: Computer Organization, Structure and Function, System Buses, Interconnection Structure.

Memory System: Memory System Overview, Internal and External Memory, Memory Chip Organization and Error Correction, Cache Memory and its Mapping Functions, Virtual Memory Management, Memory Storage Devices.

Input/Output: I/O Devices, I/O Modules, Programmed and Interrupt-Driven I/O, Direct Memory Access (DMA).

CPU/ALU: Integer and Floating Point Arithmetic, Signed Operand Multiplication, Fast Multipliers, Instruction Sets, Types of Operands, Addressing Modes, CPU Structure and Functions, Process Organization, Register Organization, Instruction Cycle, Instruction Pipelining, Arithmetic and Logic Unit (ALU), Bit Sliced ALU.

Control Unit: Micro-Operations, Hardwired Control Unit, Control Unit Operation, Micro-Instruction Sequencing and Execution, Grouping of Signals, Micro-Programmed Control Unit, Microprogram Sequencing.

High Performance Computer System: Techniques to Achieve High Performance, RISC, CISC, Introduction to Superscalar Processor, Parallel Processor, Array Processor, Multi-Programming, Vector Processing, Fault Tolerant Computing, High Performance Scientific Computing.

References:

1. Computer Organization and Architecture, 10th Edition, William Stallings, Pearson.
2. Computer Architecture: A Quantitative Approach, John L. Hennessy and David A. Patterson, Morgan Kaufmann.
3. Inside the Machine: An Illustrated Introduction to Microprocessors and Computer Architecture, 1st Edition, Jon Stoke, No Starch Press.
4. Computer Organization and Design: The Hardware/Software Interface, 5th Edition, David A. Patterson and John L. Hennessy, Morgan Kaufmann.
5. Computer Organization and Embedded Systems, 6th Edition, Carl Hamacher, Vranesic, Zaky Zvonko, Safwat Engin and Naraig Manjikian, McGraw-Hill Education.

EEE 4163	**Data and Computer Network**	**3 Credits, 3 Hours/Week**

Data Communication Networking: Data Communication Model, Network Topologies, Protocol Layer Architecture, OSI Reference Architecture, TCP/IP Reference Architecture, Local Area Network (LAN), Metropolitan Area Network (MAN) and Wide Area Network (WAN), Circuit Switching Versus Packet Switching, Datagram and Virtual Circuits, LAN, MAN and WAN Standards, Network Interconnections – Bridges, Hubs, Switches, Routers and Gateways.

Physical Layer and Media: Analog and Digital Data Transmission, Spectrum and Bandwidth, Data Rate and Channel Capacity, Transmission Impairments, Twisted-Pair, Co-Axial and Fiber-Optic Cable, Wireless Media; Multiplexing – Frequency Division Multiplexing, International FDR Carrier Standards, Synchronous Time Division Multiplexing and International TDR Carrier Standards, Statistical TDM and Wavelength Division Multiplexing, Digital Data, Digital Signals: Signal

Encoding Schemes – NRZ, NRZ-L, NRZI, Bipolar-AMI and Pseudoternary, Manchester and Differential Manchester, B8ZS, HDB3, etc.

Data Link Layer: Asynchronous and Synchronous Transmission, Flow Control and Error Control, Data Link Layer Protocols – Stop-and-Wait Flow Control, Sliding Window Flow Control, Stop-and-Wait ARQ, Go Back N ARQ, Selective Repeat ARQ, Error Detection and Error Correction, HDLC, PPP, Medium Access Control (MAC) Sublayer: Multiple Access Protocols – ALOHA, CSMA, CSMA/CD, Binary Exponential Backoff Algorithm, MACA; IEEE802.2 LLC.

Network Standards: IEEE 802.3 (Ethernet) Specifications, Fast Ethernet, Gigabit Ethernet, 10 Gigabit Ethernet, IEEE802.11 (WiFi) Protocol Architecture, Physical Layer, MAC Sublayer, IEEE 802.16 (WiMAX) Standard, Frame Relay, ATM.

Network Layer: Network Layer Design Issues – Store and Forward Packet Switching, Implementation of Connectionless Service, Implementation of Connection-Oriented Service, Routing Algorithms – The Optimality Principle, Shortest Path Routing, Flooding, Distance Vector Routing, Link State Routing, Broadcast and Multicast Routing, Routing in Ad-Hoc Networks, Congestion Control, QoS, Network Layer in the Internet – The Internet Protocol (IP), IP Address, IPv4, IPv6, Mobile IP, Internet Control Protocols – ICMP, ARP, RARP, DHCP, OSPF, BGP.

Transport Layer: The Transport Service, UDP, TCP, TCP Congestion Control.

Network Security: Introduction to Network Security, Encryption – DES, AES, Public Key Encryption and Digital Signatures, IP Security, Authentication Protocols.

References:

1. Communication Networks, Alberto Leon-Garcia & Indra Widjaja, McGraw-Hill.
2. Computer Networks & Internets with Internet Applications, Douglas E. Comer, Pearson Education.
3. High-Speed Networks and Internets: Performance and Quality of Service, William Stallings, Prentice-Hall.
4. Data and Computer Communications, 10th Edition, William Stalling, Pearson.
5. Data Communications and Networking, 5th Edition, Behrouz A. Forouzan, McGraw-Hill Education.
6. Computer Networks, 5th Edition, Andrew S. Tanenbaum and David J. Wethera, Pearson.
7. Computer Networking: A Top-Down Approach, 7th Edition, James Kurose and Keith Ross, Pearson.
8. Computer Networks: A Systems Approach, 5th Edition, Larry L. Peterson and Bruce S. Davie, Morgan Kaufmann.

EEE 4102	**Power Electronics and Industrial Automation Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 4101**

EEE 4134	**VLSI Design Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 4133**

EEE 4144	**Optical Fiber Communication Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 4143**

EEE 4154	**Power System Protection Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 4153**

EEE 4164	**Data and Computer Network Laboratory**	**1.5 Credits, 3 Hours/Week**

Laboratory based on **EEE 4163**

EEE 4100	**Project Work**	**2 Credits**

4th Year 2nd Semester

EEE 4201	**Control Engineering**	**3 Credits, 3 Hours/Week**

Introduction: Introduction to Control Systems, Definitions and Mathematical Background.

Writing System Equations: State Concepts, Transfer Function and Block Diagram, Mechanical Translation Systems, Mechanical Rotational Systems.

Solution of Differential Equations: Standard Inputs to Control Systems, Steady-State Response and Transient Response.

Laplace Transform: Definition, Laplace Transform Theorems, Application of The Laplace Transforms to Differential Equations, Inverse Transformation, Heaviside Partial-Fraction Expansion Theorems.

System Representation: Block Diagrams, Determination of the Overall Transfer Function, Standard Block Diagram Terminology, Simulation Diagrams, Signal Flow Graphs.

Control System Characteristics: Routh-Hurwitz Stability Criterion, Feedback System Types, Analysis of System, Types, Steady-Mate Error Coefficients, Non Unity-Feedback System.

Root Locus: Plotting Roots of a Characteristics Equation, Qualitative Analysis of the Root Locus, Open-Loop Transfer Function, Poles of the Control Ratio, Applications of the Magnitude and Angle Condition.

Frequency Response: Correlation of the Sinusoidal, and Time Responses, Frequency Response Curves, Bode Plots, Frequency Transfer Function Relationship, Nyquist's Criterion, Definitions of Phase Margin and their Relation to Stability.

Root Locus Compensation Design: Introduction to Design, Transient Response Dominant Complex Poles, Additional Significant Poles, Ideal Integral Cascade Compensation (PI Controller), Ideal Derivative Cascade Compensation (FD Controller), FID Controller, Introduction to Feedback Compensation.

Introduction Digital Control Systems: Introduction, Sampling, Ideal Sampling Z-Transform Theorems, Synthesis in the Z-Domain (Direct Method), The Inverse Z-Transform, Zero-Order Hold, Analog Controller Design, Basics of Digital Control, Representation of Digital Control Systems in S-Plane and Z-Plane, Interpretation of Pole-Zero Maps in Z-Plane, Frequency-Folding Effects, Digital Design by Emulation.

References:

1. Control Systems Engineering, 6th Edition, Norman S. Nise, Wiley.
2. Modern Control Engineering, 5th Edition, Katsuhiko Ogata, Pearson.
3. Linear Control System Analysis and Design, John Joachim D'Azzoand Constantine H. Houpis, McGraw-Hill.

EEE 4231	**Quantum Mechanics**	**3 Credits, 3 Hours/Week**

Operator Algebra in Quantum Mechanics: Dirac Bras and Kets, Inner Product, Linear Operator and its Adjoint, Hermitian Conjugation, Orthonormal Basis and

Operator Representation, Matrix Representation of Bras, Kets and Operators, Hermitian and Unitary Operators and their Eigenvectors and Eigenvalues, Complete Set of Commuting Observables, Commutation Relation, Unitary Evolution and Transformation, Parity Operator.

Postulates, Interpretations and Implications: Postulates and its Physical Interpretations in Quantum Mechanics, Measurement Process, Time Evolution of States, Conservation of Probabilities, Constant of Motion, Stationary States and Energy Eigenstates.

Different Representations in QM: Position Space Representation, Momentum Space Representation, Schrodinger Picture Representation, Heisenberg Picture Representation, Interaction Picture Representation, Path Integral Representation of Quantum Mechanics.

Quantum Harmonic Oscillator: Why Study Harmonic Oscillator, Review of Classical Harmonic Oscillator, Quantization of Harmonic Oscillator using Operator Algebra, Creation, Annihilation, Ladder and Number Operators.

Identical Particles: Identical Particles, Scattering of Identical Particles, Two-Particle Systems, Bosons and Fermions, Exchange Energy, The Slater Determinant.

Symmetries and Conservation Laws: Time translation Invariance and Conservation of Energy, Space Translation Invariance and Momentum Conservation, Rotational Invariance and Angular Momentum Conservation, Parity Conservation and Selection.

Spin-$\frac{1}{2}$ System: Mathematical Representation of Spin-$\frac{1}{2}$, Commutation Algebra of Spin Operators, Pauli Matrices, The Bloch Sphere, Wave function with Spin, Spinor Representation, The Pauli Equation.

Two Level System (TLS): General Model for TLS, Hilbert Space, Basis and Eigenstates of TLS, Effect of Coupling on Eigenstates and Eigenvalues, The Rabi Oscillation between Unperturbed TLS.

References:

1. Quantum Mechanics, Vol. 1, 1st Edition, Claude Cohen-Tannoudji, Bernard Diu and Frank Laloe, Wiley.
2. Introduction to Quantum Mechanics, 3rd Edition, David J. Griffiths and Darrell F. Schroeter, Cambridge University Press.
3. Quantum Mechanics for Scientists and Engineers, 1st Edition, David A. B. Miller, Cambridge University Press.
4. Principles of Quantum Mechanics, 2nd Edition, R. Shankar, Plenum Press.
5. Quantum Mechanics, 4th Edition, Walter Greiner, Springer.

EEE 4233	Nanoelectronics	3 Credits, 3 Hours/Week

The New Perspective: Introduction, Two Key Concepts, Why Electronics Flow, Conductance Formula, Ballistic (B) Conductance, Diffusive (D) Conductance, Connecting B to D, Angular Averaging, Drude Formula.

Energy Band Mode: E(p) or E(k) Relations, Counting States, Density of States, Number of Modes, Electron Density (n), Conductivity vs Electron Density (n), Quantum Capacitance.

What and Where is the Voltage: A New Boundary Condition, Quasi-Fermi Levels (QFL's), Current from QFL's, Landauer Formulas, What a Probe Measures, Electrostatic Potential, Boltzmann Equation, Spin voltages.

Heat, Electricity, Second Law and Information: Seebeck Coefficient, Heat Current, One-level Device, Second Law Entropy, Law of Equilibrium, Shannon Entropy, Fuel Value of Information.

Ballistic Nanotransistors: MOSFET Device Metrics, Traditional IV Theory, The Virtual Source Model, Depletion Approximation, 2D MOS Electrostatics Mobile Charge: Bulk MOS and Extremely Thin Silicon-on-Insulator MOS (ETSOI), The Landaur Approach, The Ballistic MOSFET, The Velocity at the Virtual Source, Revisiting the Virtual Source Model.

Transmission Theory of Nanoscale MOSFETs: Carrier Scattering and Transmission, Mean Free Path and Diffusion Coefficient, Transmission Theory of MOSFET, Semi-Classical Transport in Nanoscale MOSFETs, Quantum Transport, Connection to Virtual Source Model, Analysis of Experiments, Limits of MOSFETs.

References:

1. Lessons from Nanoelectronics: A New Perspective on Transport, Supriyo Datta, World Scientific Pub.
2. Lessons from Nanoelectronics: Fundamentals of Nanotransistor, Mark Lundstorm, World Scientific Pub.

EEE 4241	Mobile Cellular Communication	3 Credits, 3 Hours/Week

Introduction: Evolution and Concept of Mobile Radio Communication, Concept of Cellular Mobile System, Generations of Cellular Mobile Systems, Specifications of Analog Cellular Systems.

Cellular Mobile System Fundamentals: Frequency Reuse and Frequency Planning, Co-Channel Interference, Hand Off, Traffic Intensity, Grade of Service (GoS), Capacity Calculation, Trunking Efficiency, Cell Splitting, Micro Cell Zone.

Mobile Radio Propagation: Propagation Characteristics, Multipath Propagation, Multipath Fading, Delay Spread, Doppler Shift, Models for Radio Propagation.

Frequency Management and Channel Assignment: Fundamentals, Spectrum Utilization, Fundamentals of Channel Assignment, Fixed Channel Assignment, Non-Fixed Channel Assignment, Traffic and Channel Assignment, Sectorization.

Handoffs and Dropped Calls: Reasons and Types, Forced Handoffs, Mobile Assisted Handoffs and Dropped Call Rate.

Diversity Techniques: Concept of Diversity Branch and Signal Paths, Carrier to Noise and Carrier to Interference Ratio Performance.

Digital Cellular Systems: Concept of TDMA and CDMA; IS-54/136 (NA-TDMA), GSM – GSM System Architecture, Protocol Layers, GSM Air Interface Specification, IS-95, CDMA-2000, W-CDMA, Mobile Cellular Data Networks: GPRS/EDGE, IMT-2000, UMTS, HSDPA/HSUPA.

3GPP, LONG TERM EVOLUTION (LTE) and LTE Advanced: Key-Parameters, Frequency Range, FDD, TDD, Modulation Schemes, Multiple Access, MIMO Technology, Data-Rates, Channel Mapping, Types of Resource Allocation.

5G Technology: High Capacity Requirements, Expanding Connectivity Needs, Multi-Connectivity Across Bands and Technologies, Diverse Spectrum Types and Bands, New Unified Air Interface, Triangle Diagram, Multi-Antenna Technology (Beamforming).

References:

1. Signal Processing and Detection, John Cioffi.
2. Modulation and Coding for Wireless Communications, Burr A, Prentice Hall.
3. Digital Communications Fundamentals and Applications, Sklar B, Prentice Hall.
4. Wireless Communications, Andre Goldsmith, Cambridge University Press.
5. WCDMA for UMTS: HSPA Evolution and LTE, Harri Holma and Antti Toskala, John Wiley & Sons.
6. GSM Switching, Services and Protocols, J. Eberspacher and H. Vogel, Wiley.
7. GSM - Evolution towards 3rd Generation Systems, Z. Zvonar, P. Jung and K. Kammerlander, Kluwer.
8. MIMO Wireless Networks: Channels, Techniques and Standards for Multi-Antenna, Multi-User and Multi-Cell Systems, B. Clerckx and C. Oestges, Academic Press (Elsevier).
9. Wireless Communications: Principles and Practice, 2nd Edition, Theodore S. Rappaport, Prentice Hall.
10. Fundamentals of Wireless Communication, 1st Edition, David Tse and Pramod Viswanath, Cambridge University Press.
11. Mobile Wireless Communications, 1st Edition, Mischa Schwartz, Cambridge University Press.

12. Fundamentals of Mobile Data Networks, 1st Edition, Guowang Miao, Jens Zander, Ki Won Sung and Ben Slimane, Cambridge University Press.
13. Introduction to Digital Mobile Communication, 2nd Edition, Yoshihiko Akaiwa, Wiley.
14. Wireless Communications & Networks, 2nd Edition, William Stallings, Pearson.
15. 5G Mobile and Wireless Communications Technology, 1st Edition, Afif Osseiran, Jose F. Monserrat, Patrick Marsch, Mischa Dohler and Takehiro Nakamura, Cambridge University Press.
16. An Introduction to LTE, 2nd Edition, Christopher Cox, Wiley.

EEE 4243	Microwave and Satellite Communication	3 Credits, 3 Hours/Week

Microwave Generation: Klystron, Reflex Klystron, Magnetron and Microwave Semiconductor Devices, Microwave Components, Microwave Measurements: Power, Frequency, and Wavelength.

Microwave Circuit Design: Low Frequency Parameters, S-, Y-, Z-Parameter, ABCD Parameters, Transmission Matrix, Passive Circuit Design, Mixer Design, Microwave Control Circuit Design, Wireless Microwave Systems, Noise in Microwave Circuits, Microwave IC (HMICs, MMICs).

Microwave Engineering for Wireless System: Microwave Networks, Active Networks, Microwave Link, Rectifier and Detector Design, Transmitting and Receiving Equipment.

Introduction to Radar: Applications of Radar, Radar Frequencies, BasicPrinciples, Radar Equation, Minimum Detectable Signal, Factors Influencing Maximum Range, Effect of Noise, Doppler Effect, Radar Cross-Section of Targets, PRF and Range Ambiguities, Transmitter Power, System Losses.

Different Types of Radar: Basic Pulsed Radar System, Modulators, Receivers, Bandwidth Requirements, Factors Governing Pulse Characteristics, Duplexer, Moving Target Indicator (MTI), MTI Radar, Limitations to the Performance of MTI Radar, Non-Coherent MTI Radar, CW radar, FM CW Radar, Multiple Frequency CW Radar, Blind Speeds, Staggered PRF, Tracking Radar Systems (Sequential Lobing, Conical Scan), Radar Antennas, Radar Displays.

Satellite Communication: Introduction, Geo-Synchronous and Geo-Stationary Satellites, Kepler's Laws, Locating the Satellite with Respect to the Earth, Sub-Satellite Point, Look Angles, Mechanics of Launching a Synchronous Satellite, Orbital Effects.

Satellite Sub-Systems: Attitude Determination and Control Sub-systems, Mechanical Sub-system, Telemetry, Tracking and Command Control System, Power Supply System, Space Craft Antennas, Multiple Access Techniques, Earth Station Equipment, Tracking Systems.

Satellite Link Design: Basic Transmission Theory, Transmission Path, Path Loss, System Noise Temperature and G/T Ratio, Design of Down Link and Uplink, Impact of G/T- Saturation Flux Density (SFD)-Effective Isotropic Radiated Power (EIRF) on System Design.

Miscellaneous: Satellite Communication for Internet (VSAT), Global Navigation Satellite System (GNSS) i.e., GPS/GLONASS/Galileo/Beidou, Satellite Television (DBSSatellite), Geographic Information System (GIS) and Remote Sensing, CubeSat, NanoSat.

References:

1. Introduction to Radar Systems, 2nd Edition, Merrill I. Skolnik, McGraw-Hill.
2. Principles of Modern Radar: Basic Principles, Mark A. Richards, James A. Scheer and William A. Holm, Scitech Publisher.
3. Radar: Principles, Technology, Applications, Byron Edde, Pearson.
4. Satellite Communications, Timothy Pratt and Charles Bostian, John Wiley.
5. Satellite Communications, Dennis Roddy, McGraw-Hill.

EEE 4251	**Power System Operation and Control**	**3 Credits, 3 Hours/Week**

Power System Operation: Overview of Operating Principles of Power System.

Power System Operations: State Estimation, Load Forecasting, Unit Commitment, Economic Dispatch, Optimal Power Flow.

Frequency Control: Generation and Turbine Governors, Droop, Frequency Sensitivity of Loads, Area Control Error (ACE), Automatic Generation Control (AGC) and Coordination with Unit Commitment and Economic Dispatch, Frequency Collapse and Emergency Load Shed.

Power System Security: Static and Dynamic; Security Constrained OPF.

Demand Side Control: Distribution Management System, Demand Side Management, and Smart Grid Concept.

Power System Monitoring: Real Time Operation- SCADA, Energy Management System, Various Data Acquisition Devices – Remote Terminal Unit (RTU), Intelligent Electronic Device (IED), Phasor Measurement Unit (PMU), Frequency Disturbance Recorder (FDR), Wide Area Monitoring, Protection and Control(WAMPAC).

Electricity Market Operation: GenCos, ISO, DisCos, Bidding, Spot Market, Social Welfare, Market Clearing Price (MCP), Locational Marginal Price (LMP), Bilateral Contracts and Forward Market, Hedging.

Reference:

1. Power System Stability and Control, 1st Edition, Prabha Kundur, McGraw Hill.
2. Elements of Power System Analysis, William D. Stevenson, McGraw-Hill.
3. Electric Energy Systems-Analysis and Operation, 1st Edition, Antonio Gomez Exposito, Antonio J. Conejo and Claudio Canizares, CRC Press.
4. Power Generation, Operation, and Control, 3rd Edition, Allen J. Wood, Bruce F. Wollenberg, and Gerald B. Sheble, Wiley-Interscience.
5. Electric Power Engineering Handbook, Leonard L. Grigsby, CRC Press.
6. Power System Dynamics: Stability and Control, 2nd Edition, Jan Machowski, Janusz W. Bialek, and James R. Bumby, Wiley.
7. Smart Grid- Technology and Applications, Janaka Ekanayake, Kithsiri Liyanage, Jianzhong Wu, Akihiko Yokoyama and Nick Jenkins, Wiley.

EEE 4253	**Power Plant Engineering**	**3 Credits, 3 Hours/Week**

Sources of Energy: Fossil Fuel-Coal, Oil, Natural Gas, Coal Classification, Coal Composition and Analysis, Coal Properties, Oil Composition and Analysis, Combustion of Fuels.

Steam Power Plants: Thermodynamic Cycles and use of High Steam Pressure and Temperature, Superheating of Steam, Reheat Cycle, Regenerative Cycle, Binary Vapour Cycle, Steam Generators- Economiser and Air Preheater, Condenser, Supply of Cooling Water to Condenser, Cooling Towers.

Gas Turbine Power Plants: Operation of Gas Turbine Power Plant, Open Cycle Plant, Closed Cycle Plant, Combined Gas Turbine and Steam Turbine Cycle.

Hydro Electric Plants: Selection of Site, Classification and Basic Schemes, Types of Turbines, Capacity Calculation, Pump Storage Projects.

Nuclear Power Plant: Types of Fuels, Classification of Reactors, Methods of Cooling, Moderators, Methods of Control, Safety Measures, Nuclear Reactor-Boiling Water Reactor, Pressurized Heavy Water Reactor, Fast Breeder Reactor, Cost of Nuclear Energy.

Other Power Sources: Principle of MHD Power Generation, Open Cycle MHD System and Closed Cycle MHD System, Tidal, Wind and Geothermal Power Generation, Solar Power Plant.

Power Plant Economics: Load Curves, Electric Power Generation Cost, Power Station Performance and Operation Characteristics.

References:

1. Electric Power Generation, Transmission and Distribution, Leonjard L. Grigsby, CRC Press.

2. Power Station Engineering and Economy, 1st Edition, Bernhardt G.A. Skrotzki and William A. Vopat, McGraw-Hill Education.
3. Power Plant Technology, M. M. El-wakil, McGraw-Hill.
4. Power plant Engineering, P. K. Nag, Tata McGraw-Hill.

EEE 4261	Artificial Intelligence	3 Credits, 3 Hours/Week

Introduction to Artificial Intelligence (AI): AI Programming Language: Prolog, Environment Types, Agent Types, Agent Model, Reactive Agents, Perception: Neurons – Biological and Artificial, Perceptron Learning, Linear Reparability, Multi-Layer Networks, Problem Solving and Searching: 8-Puzzle Problem, N-Queen Problem, Robotic Arm Assembly, General Search.

Review of Un-Informed Search Strategies: Breadth First Search, Uniform Cost Search, Depth-First Search, Iterative Deepening, Bidirectional Search; Informed Search Algorithms: Breath-First Search, A* Search, Beam Search, Heuristic Searching, Memory Bounded Search (e.g., IDA*, RBFS, SMA*).

Local Searches: Hill Climbing, Simulated Annealing, Constraint Satisfaction Problems, Genetic Algorithm, Motion Planning: Motion Planning Search, Configuration, Action and Obstacle, Road Map, Game Playing: Motivation, Minimax Search, Resource Limits and Heuristic Evaluation, A-B Pruning, Stochastic Games, Partially Observable Games, Continuous, Embodied Games.

Neural Networks: Multi-Layer Neural Networks, Backpropagation, Variations on Backprop, Cross Entropy, Weight Decay, Momentum, Training Tips, Applications ALVINN, TD-Gammon.

Machine Learning: Supervised Learning, Decision Trees, Reinforcement Learning, Exploration vs. Exploitation, Q-Learning, Temporal Difference Learning, General Concepts of Knowledge, Knowledge Representation, Frame Problem, Representing Time, Events and Actions, Utility and MEU, Value of Information, Decision Networks, Value Iteration Algorithm, Partially Observable Markov Decision Process, Introduction to Game Theory.

Logical Agent: Knowledge-Based Agents, Logic in General- Models and Entailment, Propositional (Boolean) Logic, Equivalence, Validity, Satisfiability, Inference Rules and Theorem Proving- Forward Chaining, Backward Chaining, Resolution.

First Order Logic: Universal and Existential Quantifiers, Keeping Track of Change, Inference in First Order Logic Planning, Situation Calculus, Belief Networks, Probabilistic Reasoning, Hidden Markov Model and the Dynamic Bayesian Network, Logical Inference, Communication, Robotics.

References:

1. Artificial Intelligence: A Modern Approach, 3rd Edition, Stuart J. Russell and Peter Norvig, Pearson.
2. Artificial Intelligence, 3rd Edition, Patrick Henry Winston, Addison-Wesley.
3. Artificial Intelligence: What Everyone Needs to Know, 1st Edition, Jerry Kaplan, Oxford University Press.
4. Artificial Intelligence and Intelligent Systems, 1st Edition, N. P. Padhy, Oxford University Press.

EEE 4263	Data Base Management System	3 Credits, 3 Hours/Week

Introduction: General Overview and Purpose of DBMS, Advantages, Applications, Common Features and Overall Structure of the Database.

Data Modelling: Relational Model: Structure of Relational Model, Key Constraints, Referential Integrity Constraints, General Constraints, Relational Algebra – Fundamental, Additional and Extended Operations, Aggregate Functions, Outer Joins and Database Modification using RA, ER Model: Entity and Relationship Sets, Constraints – Key, Mapping Cardinality and Participation Constraints, Strong and Weak Entity Sets, E-R Diagram, Class Hierarchies, Aggregation, Conceptual Database Design with the ER Model, Converting ER to Relational Model, Object-Relational Data Model: Complex Data Types, Structured Types and Inheritance, Implementing O-R Features.

Relational Database Design: Features of Good Relational Design, Functional Dependency Theory - Basic Concept, Uses, Closure of a Set of FDs, Closure of Attribute Sets, Canonical Cover, Algorithms for FDs, Decomposition using FDs and its Desirable Properties, Atomic Domains and First Normal Form, BCNF and 3NF, Multivalued Dependencies and Fourth Normal Form, Decomposition Algorithms for Different Normal Forms, Database Design Process.

Database Application Development: Database Management Systems (DBMSs), SQL: Data Definition and Data Manipulation Languages, Integrity Constraints, Basic Queries, Nested and Complex Queries, Modification of the Database, Views: Definition, Update on Views, Cursors, Extending DBMS Functionality: Stored Procedures, Assertions and Triggers, Embedded and Dynamic SQL, DBMS Administration: DBA, Users, Privileges, Security, Performance, ODBC, JDBC, Web/Database Architectures.

DBMS Implementation Technology: Storage and File Structure: Different Storage Types, File and Record Organization, Data Dictionary Storage, Indexing and Hashing: Basic Concepts, Ordered Indices, B+-Tree Index Files, B-Tree Index Files, Static and Dynamic Hashing, Comparison of Ordered Indexing and Hashing.

Query Processing: Overview, Measures of Query Costs, Selection Operation, Sorting, Join Operation, Other Operations, Evaluation of Expressions, Query Optimization: Introduction, Transformation of Relational Expressions, Evaluation Plan.

Transaction Processing: Transactions: Concepts, ACID Properties, Transaction States, Concurrent Schedules, Serializability- Conflict and View Serializability, Recoverability, Concurrency Control: Lock-Based Concurrency Control, Two-Phase Locking, Problems with Locking, Locking and Starvation, Deadlock–Prevention, Detection and Recovery.

Introduction to Modern Database Systems: Object-Relational Databases, Deductive Databases, Spatial Databases, Temporal Databases, Multimedia Databases, Mobile Databases and Advanced Relational Databases.

References:

1. Principles of Database Management, 1st Edition, Wilfried Lemahieu, Seppe vanden Broucke, and Bart Baesens, Cambridge University Press.
2. Introduction to Database Management, Mark L. Gillenson, Wiley.
3. Fundamentals of Database Systems, 7th Edition, Ramez Elmasri and Shamkant B. Navathe, Pearson.
4. Database System Concepts, 6th Edition, Abraham Silberschatz Professor, Henry F. Korth, and S. Sudarshan, McGraw-Hill Education.
5. Database Systems Design, Implementation, and Management, Carlos Coronel, Steven Morris, Peter Rob, Course Technology.
6. Fundamentals of Database Systems, 7th Edition, Ramez Elmasri and Shamkant B. Navathe, Pearson.

EEE 4271	**Renewable Energy Technology**	**3 Credits, 3 Hours/Week**

Radiations: Radiation Characteristics of Materials: Absorptance, Emittance, Reflectance and Selective Surfaces, Modes of Heat Transfer.

Solar Collectors: Flat Plate Collectors, Concentrating Collectors, Solar Distillation, Solar Energy Systems for Process Heating, Solar Thermal Power Generation, Solar Refrigeration, Solar Thermal System Optimization and Performance Study, Solar Thermal Modeling.

Solar Photovoltaic Energy Conversion: Solar Cell Fundamental, Basic Principle, Types of Solar Cells, P-N Junction as Photovoltaic Cell, Heterojunction, Schottky Barrier Junction, Fabrication of Solar Cell, Effect of Irradiance and Temperature on Solar Cells, Effect of Shading, hotspot formation, Thin-Film Solar Cell, Multi-Sun Solar Cells, Fabrication of Photovoltaic Modules, Dimension of Cells, Packing

Efficiency of Cells in Modules, Characterization of Cells and Modules, Organic and Polymer Matrix for the Fabrication of Solar Cell, Nanostructure Solar Cell.

Storage and Power Conditioning System: Batteries- Construction, Operation, DoD, Efficiency etc. Battery Charge Controllers. Inverters, Maximum Power Point Trackers (MPPT).

Different Types of PV System: Stand-Alone PV System. Solar Home System, Grid-Tied PV System and Hybrid System, Design of PV System, Stand Alone PV System Sizing.

Other Non-Conventional Energy Options: Wind, Geothermal, OTEC, Wave Energy, Biomass, MHD, Chemical Energy, Fuel Cell, Hydro Enrgy, Nuclear Fission and Fusion.

References:

1. Applied Photovoltaics, 3rd Edition, Stuart R. Wenham, Martin A. Green, Muriel E. Watt, Richard Corkish and Alistair Sproul, Routledge.
2. Handbook of Photovoltaic Science and Engineering, 2nd Edition, Antonio Luque, Steven Hegedus, Wiley.
3. Physics of Solar Cells, 1st Edition, Jenny Nelson, Imperial College Press.
4. Fundamentals of Solar Cells: Photovoltaic Solar Energy Conversion Paperback, Richard H. Bube, Academic Press.
5. Photovoltaic Systems Engineering, 3rd Edition, Roger A. Messenger and Amir Abtahi, CRC Press.
6. Solar Engineering of Thermal Processes, 4th Edition, John A. Duffie (Author), William A. Beckman, Wiley.
7. Solar Cells: Operating Principles, Technology and System Applications, Martin A. Green, University of New South Wales Press.
8. Renewable Energy: Power for a Sustainable Future, 3rd Edition, Godfrey Boyle, Oxford University Press.
9. Renewable Energy: A Primer for the Twenty-First Century, Bruce Usher, Columbia University Press.
10. Introduction to Renewable Energy for Engineers, 1st Edition, Kirk D. Hagen, Pearson.

EEE 4202	**Control Engineering Laboratory**	**3 Credits, 3 Hours/Week**

Laboratory based on **EEE 4201**

EEE 4272	**Renewable Energy Technology Laboratory**	**3 Credits, 3 Hours/Week**

Laboratory based on **EEE 4271**

EEE 4200	**Project work**	**4 Credits**

Additional Course Contents

GED 4103	**Industrial Sociology**	**3 Credits, 3 Hours/Week**

Sociology: Modernity and Social Changes in Europe and Emergence of Sociology.

Sociology as Science: Science, Scientific Method and Critique.

Sociological Thinkers: Karl Marx, Emile Durkheim, Max Weber, Talcolt Parsons, Robert K, Merton, George Herbert Mead.

Industrial Sociology: Nature, Scope and Importance of Industrial Sociology, Social Relations in Industry, Social Organization in Industry, Rise and Development of Industry: Craftsmanship, Proto Industrial Revolution, Industrial Revolution, 1^{st}, 2^{nd}, 3^{rd} and 4^{th} Industrial Revolution and Changing Labor Force, The Economy – Structure and Change: Economy and Influence of Technology on Economy.

Industry and Education: Impacts of Industry on the Educational System.

Industry and Family: The Inter-Relationship between Industrial Organizations and the Family, Industry and Social Stratification: The Impact Industry on the Stratification System, Industry, The Community and the Polity: Effects of Industry on the Community and Political Decisions in the Societal Environment.

Sociology of Profession: Sociological Aspects of Profession, Professions and Power, Professionals and Society Relationship, Aspiration of Society on Professionals, Sociological Perspectives of Professional Ethics.

Labor Market Sociology: Sociology of Employment and Labor Migration, Social and Economic Factors of Labor Wage Determination, State Intervention on Minimum Wage, Gender Issues in Labour Market, Formal vs Informal Labour Market, Discrimination and Equity in Employment, Enforcement Equal Opportunity.

Workplace Sociology: The Workers' Approach to Behaviour in the Work Situation, Increasing Complexity of the Workplace Situation and the Various

Approaches to Behaviour, Industrial Counselling, Motivation and Different Behaviour Modification Strategy, Mental Health in Workplace and Different Coping Strategy of Workplace Change and Rural-Urban Migration.

Trade Unionism: Trade Unions and the Industrial Relations Process, Grievances and Grievance Handling Procedure, Industrial Disputes: Strikes and Lockouts, Preventive Machinery of Industrial Disputes and Schemes of Workers Participation in Management.

Labour Court: Structure and Functioning, Bangladesh Labour Laws, Restorative Justice in Labor Welfare.

Labour Welfare: Scope of Labour Welfare, Evolution of Labour Welfare, Labour Welfare in Bangladesh.

References:

1. Fundamentals of Industrial Sociology, Gilbert Pascal, Tata McGraw Hill.
2. Industrial Sociology, 2nd Edition, Engno V. Schneider.

GED 4105	**Industrial Psychology**	**3 Credits, 3 Hours/Week**

Introduction to Industrial Psychology: Historical Background of Industrial Psychology, Industrial Psychology and its Relationship to Talent Management, Job Analysis, Talent Acquisition: Selection and Recruitment Related Psychological Assessment, Organizational Learning, Training and Development, Performance Appraisal and Performance Management, Leadership.

Team and Teamwork Employee Engagement: Affect, Attitudes, and Behaviour at Work, Work Motivation, Employee Well-Being at Work: Workplace Psychological Health, Stress and Well-Being at Work, Job Design and Organizational Development, Employee Satisfaction and Organizational Communication Union/Management and Industrial Relations.

Reference:

1. Industrial/Organizational Psychology: An Applied Approach, 8th Edition, Michael G. Aamodt, Cengage Learning.

GEG 4107	**Engineering Economics**	**3 Credits, 3 Hours/Week**

Introduction to Engineering Economics: Types of Decisions in Engineering Economics, Limitations of Engineering Economics, Fundamental Principles of Engineering Economics, Cash Flow Diagrams, Interest Rates and Time Value of Money, Debt Management.

The Three Worths: Present Worth, Annual Equivalence, Future Worth, Evaluation of Alternatives Based on Time Value of Money, Capitalized Costs, Capitalized Recovery, Life Cycle Cost Analysis.

Rates of Return: Return on Investment (ROI), Internal Rate of Return (IRR), Incremental IRR, Mutually Exclusive Alternatives.

Benefit-Cost Analysis: Benefit-Cost Analysis (BCA) used in Public Sector Projects, Valuation of Benefits and Costs, Benefit-Cost Ratio (BCR).

Depreciation and Financial Statements: Depreciable Us. Non-Depreciable Assets, Types of Depreciation, Introduction to Income Statements, Introduction to Cash Flow Statements after Tax Analysis: Corporate Taxes, Treatment of Capital Gains and Losses, Treatment of Non-Cash Expenses, After Tax Cash Flow: Developing Cash Flow Statements, Developing Cash Flow Equations.

Inflation: Introduction to Inflation, Measuring Inflation, Equivalence Calculation under Inflation, Impact of Inflation on Capital Projects.

Retirements and Replacements: Economic Life, Replacement Analysis under Different Conditions, Replacement Analysis with after Tax Consideration.

Cost Concepts and Capital Budgeting: General Cost Concepts, Classification of Costs, Introduction to Capital Budgeting, Cost of Capital, Choice of MARR, Capital Budgeting Decisions.

Sensitivity Analysis: Break-Even Analysis, Sensitivity Analysis, Evaluating Mutually Exclusive Alternatives using Sensitivity Analysis Decision and Risk Analysis: Project Risk, Introduction to Probability Concepts for Investment Decisions, Probability Distribution for NPW Decision, Comparing Mutually Exclusive Risky Alternatives, Risk Simulation, Decision Tree Analysis in Investment Decisions.

Reference:

1. Contemporary Engineering Economics, 4th Edition, Chan S. Park, Prentice-Hall.

EEE 4x35	**Advanced Semiconductor Devices**	**3 Credits, 3 Hours/Week**

Heterojunction Devices: Physics Background on Heterostructure, Quantum Well, Superlattice, Modulation Doping, Band Alignment, Band Offset, Anderson's Rule, Single and Double Sided Hetero-Junctions, Quantum Wells and Quantization Effects, Two-Dimensional Electron Gas (2DEG), Lattice Mismatch and Strain and Common Hetero-Structure Material Systems, High Electron Mobility Transistors (HEMTs) Devices: Operation Principle and I-V Characteristics.

Multigate Devices: Transistor and Multiple-Gate MOSFET's Development History, Issues in Short-Channel MOSFET Electrostatics, Scale Length

Fundamentals for Thin-Body MOSFETs (FinFET, Planar Fully-Depleted SOI MOSFET and Gate-All-Around MOSFET), Advantages of Thin-Body MOSFET's Electrostatics Quantum Mechanical Effects, Effective Carrier Mobility, High-Field Velocities, Parasite Resistance, Thin-Body MOSFET's Carrier Transport, Impacts of Substrate, Fin Shape Tuning, Gate Stack Process FinFET's Source/Drain Process, Multiple-Gate MOSFET's Threshold Voltage Engineering Multiple-Gate MOSFET Performance Dependence on Channel Orientation and Strain, Strained-Si Technology and its Effectiveness on Multiple-Gate MOSFETs, SoC Potentials For Multiple-Gate MOSFETs, 3-Dimensional Integrations, Reliability Issues.

Tunneling Devices: Resonant Tunneling Diodes: Physics and Operation, Resonant Tunneling Transistors, Device Physics, Operation and Characteristics.

Single Electron Transistor: Basic Device Physics, Operating Principle and I-V Characteristics, Coulomb Blockade and Coulomb Diamonds.

CNT, Graphene and 2D Semiconductor Devices: Basic Device Physics, Operating Principle and I-V Characteristics of CNT-FET, Graphene Devices, MOS2 and Transition Metal Dichalcogenide (TMD) Devices, 2D Memristors.

Spintronic Devices: Introduction to Spintronics, Quantum Mechanics of Spin, Spin-Orbit Interaction, Spin Relaxation, Spin Dependent Scattering, Tunneling and Transport, Spin Injection, Spin Transistor: Basic Operation and I-V Characteristics, Spin-Valve, Spin-Tunneling and Sensor Devices, Quantum Computing Devices.

Advanced FET Devices: Basic Device Physics, Operation Principle, I-V Characteristics and Fabrication of DNA-FETs, Detection Principle of Biological and Chemical FET Sensors, Negative Capacitance FETs, Transistors, Nanowire FETs, Organic FETs.

References:

1. Physics of Semiconductor Devices, 3rd Edition, S. M. Sze and Kwok K. Ng, Wiley.
2. Quantum Transport Atom to Transistor, S. Datta, Cambridge University Press.
3. Electronic Transport in Mesoscopic Systems, S. Datta, Cambridge University Press.
4. Semiconductor Spintronics and Quantum Computation, D.D. Awschalom, N. Samarath, and D. Loss, Springer.
5. Carbon Nanotubes: Properties and Applications, Michael J. O'Connell, CRC Press.
6. Fundamentals of Modern VLSI Devices, Y. Taur and T.H. Ning, Cambridge University Press.
7. FinFET and Other Multi-Gate Transistors, J.-P. Colinge, Springer.
8. Silicon-On-Insulator Technology, 3rd Edition, J.-P. Colinge, Springer.

EEE 4x45	Digital Image Processing	3 Credits, 3 Hours/Week

Introduction: Image Formation and Representation, Brightness Adaption and Discrimination, Pixels, Coordinate Conventions, Imaging Geometry, Perspective Projection and Transform, Image Acquisition and Digitization, Human Eyes and Visual Perception, Intensity Transformations and Spatial Filtering, Filtering in Frequency Domain.

Image Transformations: DFT, DCT Hadamar, and Haar, Image Restoration and Reconstruction, Introduction to Image Compression.

References:

1. Digital Image Processing, R. C. Gonzalez, R. E. Woods.
2. Fundamentals of Digital Image Processing, A. K. Jain, Prentice Hall of India, 1989.

CSE 4x47	Network and Information Security	3 Credits, 3 Hours/Week

Overview: Security Goals, The OSI Security Architecture, Security Attacks, Services and Mechanism, A Model for Network Security.

Symmetric Ciphers: Classical Encryption Techniques, Block Ciphers and the Data Encryption Standard (DES), Basic Concepts in Number Theory and Finite Fields, Advanced Encryption Standard (AES), Block Cipher Operation, Pseudorandom Number Generation and Stream Ciphers.

Asymmetric Ciphers: Mathematics of Asymmetric-Key Cryptography, Public-Key Cryptography and RSA, Diffie-Hellman Key Exchange Algorithm, Man-in-the-Middle Attack, other Public-Key Cryptosystems.

Cryptographic Data Integrity Algorithms: Cryptographic Hash Functions: Secure Hash Algorithm (SHA), Message Authentication Codes: Security, Requirements, HMAC, Digital Signatures: Properties, Attacks and Forgeries, Digital Signature Standards.

Mutual Trust: Key Management and Distribution: Symmetric-Key Distribution, Public Key Distribution, Public Key Infrastructure, X.509 Certificates, User Authentication: Kerberos, Personal Identity Verification.

Network and Internet Security: Network Access Control and Cloud Security, Transport-Level Security: SSL, TLS, HTTPS and SSH, Wireless Network Security: IEEE 802.11i, Electronic Mail Security: PGP, S/MIME and DKIM, Network Layer Security: IPsec and Internet Key Exchange (IKE).

System Security: Intruders, Intrusion Detection System (IDS), Password Management, Malicious Software, Viruses, Worms, Antivirus Approaches,

Distributed Denial of Service (DDoS) Attacks, Firewalls, Cybercrime: Legal and Ethical Aspects.

References:

1. Network Security: Private Communication in a Public World, Kaufman, C, Perlman, R and Speciner, M., Prentice Hall.
2. Applied Cryptography, Schneier, B., John Wiley.
3. Cryptography and Network Security Principles and Practice, William Stallings, Pearson education.
4. Cryptography and Network Security, Behrouz A. Forouzan and Debdeep Mukhopadhyay, McGraw Hill education.
5. Security Engineering, Ross Anderson, Wiley.
6. Cryptography Engineering Design Principles and Practical Applications, Ferguson, Schneier, and Kohno, John Wiley & Sons.
7. Introduction to Computer Security, Matt Bishop, Addison Wesley Professional.
8. Computer Security: Principles and Practice, William Stallings, Pearson education.
9. Security in Computing, Charles Pfleeger, Prentice Hall.
10. Introduction to Computer Security, Michael Goodrich and Roberto Tamassia, Addison Wesley.

EEE 4x55	**High Voltage Engineering**	**3 Credits, 3 Hours/Week**

High Voltage DC Generation: DC Generation, Rectifier Circuits, Voltage Multipliers, Van de Graaf and Electrostatic Generators, Applications.

High Voltage DC Transmission Grids: DC Grid Planning, Topology, Power-Transfer Security, DC Grids with Line-Commutated Converters, DC Grids with Voltage Source Converters, DC Grid Control, DC Grid Fault Management and DC Circuit Breakers.

High Voltage AC Generation: AC Generation, Cascaded Transformers and Tesla Coils, Impulse Voltage: Shapes, Mathematical Analysis, Codes and Standards, Single and Multi-Stage Impulse Generators, Tripping and Control of Impulse Generators.

High Voltage Protection: Breakdown in Gas, Liquid and Solid Dielectric Materials, Corona, High Voltage Measurements and Testing, Over-Voltage Phenomenon and Insulation Coordination, Lightning and Switching Surges, Basic Insulation Level, Surge Diverters and Arresters.

High Voltage Measurements and Testing: IEC and IEEE Standards, Sphere Gap, Electrostatic Voltmeter, Potential Divider, Schering Bridge, Megaohm Meter, HV Current and Voltage Transducers: Contact and Noncontact.

References:

1. High Voltage Engineering: Fundamentals, 2nd Edition, E. Kuffel, W.S. Zaengl and J. Kuffel, Newnes Publication.
2. High Voltage Engineering, Farouk A.M. Rizk and Giao N. Trinh, CRC Press.
3. High Voltage Engineering, Andreas Küchler, Springer.
4. High-Voltage Direct-Current Transmission, Dragan Jovcic and Khaled Ahmed, Wiley.
5. High Voltage and Electrical Insulation Engineering, Ravindra Arora and Wolfgang Mosch, IEEE Press.
6. HVDC and FACTS Controllers, Vijay K. Sood, Springer.

CSE 4165	Big Data Analytics	3 Credits, 3 Hours/Week

Introduction: Big Data and its Importance, Big Data Characteristics, Types of Big Data, Infrastructure for Big Data, Big Data Analytics Applications.

Mining Data Streams: Introduction to Stream Concepts, Stream Data Model and Architecture, Stream Computing, Sampling Data in a Stream, Filtering Streams, Counting Distinct Elements in a Stream, Real-Time Analytics Platform (RTAP) Applications.

Big Data Technologies: Open Source Technology for Big Data Analytics, Cloud and Big Data, Predictive Analytics, Crowd-sourcing Analytics, Inter-Firewall and Trans-Firewall Analytics, Information Management.

Big Data Processing: Integrating Disparate Data Stores, Mapping Data to Programming Framework, Connecting and Extracting Data from Storage, Transforming Data for Processing, Map Reduce Types, Formats and Features, Hadoop Environment, Sub-dividing Data for Hadoop Map Reduce.

Machine Learning: Distributed Computing for Big Data, Machine Learning Regression and Classification Models, Deep Learning Algorithm, Training Deep Neural Network (DNN), Use of Auto-Encoders, Dropout Regularization and Early Termination of DNN, Text Analytics, Natural Language Processing.

References:

1. Big Data Analytics, 1st Edition, S. Acharys and S. Chellappan, Wiley.
2. Intelligent data Analysis-An Introduction, 2nd Edition, M. Berthold and D. J. Hand, Springer.
3. Understanding Big Data Analytics for Enterprise Class, Hadoop and Streaming Data, P. C. Zikopoulos, C. Eaton, D. deRoos, T. Deutsch and G. Lapis, McGraw-Hill.
4. Data Mining Concepts and Techniques, 2nd Edition, J. Han and M. Kamber, Elsevier.

CSE 4167	Object Oriented Programming	3 Credits, 3 Hours/Week

Overview: Philosophy of Object Oriented Programming (OOP), Advantages of OOP over Structured Programming.

Object Oriented Concepts: Modeling Problems using Object Oriented Concepts: Modularity, Encapsulation/Data Hiding, Immutability, Inheritance and Polymorphism, Object Oriented vs. Procedural Programming, Basics of Object Oriented Programming Language, Introduction to UML.

Objects and Classes: Attributes and Functions, Identifying Classes, UML Class Diagrams, Access Modifiers, Parameterised Types (Generics).

Pointers, References and Memory: Pointers and References, Reference Types, The Call Stack, The Heap, Iteration and Recursion, Pass-By-Value and Pass-By-Reference.

Lifecycle of an Object: Constructors and Chaining, Destructors, Finalizers, Garbage Collection: Reference Counting, Tracing, Functions or Methods, Overloading Methods, Access Control, Special Considerations in Different Languages.

I/O: Stream and Files: Output Streams, Input Streams, File Streams, String Streams.

Inheritance: Inheriting Classes, Subclass, Super Class, Access Control, Inheritance Hierarchy, Casting, Shadowing, Overloading, Overriding, Dynamic Binding, Abstract Class, Inner Classes, Special Considerations in Different Languages, Multiple Inheritance, Interfaces.

Exception and Exception Handling: Exception Handling Fundamentals, Exception Types, Chained Exception, Creating Own Exception Subclasses or Custom Exceptions, Checked vs Unchecked, Inappropriate use of Exceptions, Assertions.

Copying Objects: Shallow and Deep Copies, Copy Constructors, Cloning, Cloneable as a Marker Interface.

Generics or Templates: Template Functions and Classes, Multi-Threaded Programming, Special Considerations in Different Languages.

Package/Namespace: Understanding and Implementing Package/Namespace.

Object-Oriented Design Principles and Examples: Introduction to Object-Oriented Design Principles and Examples, Introduction to Design Patterns, Open-Closed Principle, Examples of Singleton, Decorator, State, Composite, Strategy, Observer.

Case Study Using Object Oriented Programming [**Reference Languages: C++ and Java**]

References:

1. Java: How to Program, Paul Deital and Harvey Deital, Prentice Hall.
2. C++ How to Program, Paul Deital and Harvey Deital, Pearson Education.
3. Java in a Nutshell: a Desktop Quick Reference, D. Flanagan, O'Reilly.
4. The C++ Programming Language, Bjarne Stroustrup, Addison-Wesley.
5. C++ Primer, Stanley Lippman, Pearson Education.
6. Object Oriented Programming using C++, Robert Laffore, Sams Publishing.
7. Java the Complete Reference, Herbert Schildt, McGraw Hill.
8. Object-Oriented Analysis and Design with Applications, Grady Booch, Robert A.Maksmichuk, Michael W.Engle, Bobbi J.Young, Jim Conallen, Kelli A. Houston, Pearson Education.
9. UML Distilled, Martin Fowler, Pearson Education.
10. Design Patterns: Elements of Reusable Object-Oriented Software, Erich Gamma, Richard Helm, Ralph Johnson & John Vlissides, Addison-Wesley Professional.
11. Object-Oriented System Development, Ali Bahrami, Tata McGraw Hill.
12. Teach Yourself C++, Herbert Schildt, Osborne McGraw-Hill.

CSE 4265	**Internet of Things**	**3 Credits, 3 Hours/Week**

Introduction and Concepts: Introduction to Internet of Things, Introduction to Arduino Programming, Brief History and evolution of IoT, Physical Design of IoT, Logical Design of IoT, IoT Enabling Technologies, IoT Levels.

Developing IoTs and Logical Design using Python: Introduction, IoT Design Methodology, Installing Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date/ Time Operations, Classes, Python Packages.

IoT Physical Devices and Endpoints: IoT Devices, Exemplary Device, Board, and Linux on Raspberry Pi, Interfaces, and Programming and IoT Devices.

Domain Specific IoTs: Cloud Computing, Sensor-Cloud, Connected Vehicles, Smart Grid, Industrial IoT, Home Automation, Cities, Environment, Energy, Retail, Logistics, Agriculture, Industry, Health and Life Style, Cloud Computing.

References:

1. Internet of Things: A Hands-On- Approach, Vijay Madisetti and Arshdeep Bahga, Orient Blackswan.
2. Designing the Internet of Things, 1st Edition, Adrian McEwen, Wiley.

3. Internet of Things: Architectures, Protocols and Standards, 1st Edition, by Simone Cirani, Gianluigi Ferrari, Marco Picone and Luca Veltri, Wiley.

CSE 4267	Neural Networks and Fuzzy Systems	3 Credits, 3 Hours/Week

Neural Networks: Artificial Neural Networks, Mcculloch-Pitts Networks, Perceptrons, Regression and Least Mean Square Algorithm, Multilayer Perceptrons, Radial-Basis Function Networks, Support Vector Machines, Unsupervised Learning and Self-Organization, Boltzmann Machines and Deep Networks Convolutional Networks, Recurrent Networks.

Fuzzy Logic: Introduction, Fuzzy Logic, Fuzzy Sets, Membership Functions, Features of MFs, Operations on Fuzzy Sets, Linguistic Variables, Linguistic Hedges, Fuzzy Relations, Fuzzy if–then Rules, Fuzzification, Defuzzification, Inference Mechanism: Mamdani Fuzzy Inference, Sugeno Fuzzy Inference, Sukamoto Fuzzy Inference, Defuzzification Methods, Properties of Defuzzification, Analysis of Defuzzification Methods.

Fuzzy Systems and Applications: Introduction, Fuzzy Modelling, Fuzzy Control, Design of Fuzzy Controller: Types of Fuzzy Controllers, PD/PI/PID-Like Fuzzy Logic Controllers, Modular Fuzzy Controller, Case Studies: Robotic Arm Control, Unmanned Air-vehicle Control, Smart Car Control, Household Appliances.

References:

1. Neural Networks and Learning Machines, 3rd Edition, Simon Haykin. Pearson,
2. Deep learning, Ian Goodfellow, Yoshua Bengio, and Aaron Courville. MIT Press.
3. Computational Intelligence: Synergies of Fuzzy Logic, Neural Networks and Evolutionary Computing, 1st Edition, N. Siddique N and H.Adeli, John Wiley & Sons.
4. Intelligent Control: A Hybrid Approach Based on Fuzzy Logic, Neural Networks and Genetic Algorithms, N. Siddique, Springer.

CSE 4269	Robotics and Embedded Systems	3 Credits, 3 Hours/Week

Introduction: Definition and Classification of Robots, Laws of Robotics, Applications of Robots, Basic Components of Robot Systems.

Mechanical Design of Robots: Links and Joints, Kinematic Chain, Mechanisms and Machines, Degrees of Freedom, Robot End Effectors.

Spatial Descriptions and Transformations: Description of Position, Orientation and Frames, Homogeneous Transformations.

Manipulator Kinematics: Link Parameters and Link Co-ordinate Systems, D-H Homogeneous Transformation Matrices, Forward and Inverse Kinematics of Serial Manipulators.

Manipulator Dynamics: Recursive Newton-Euler Formulation of Serial Manipulator, Lagrangian Formulation of Serial Manipulator.

Robot Control Architecture: Trajectory Planning, Control of Manipulators, Motor Control, Robot Sensors, Low Level Robot Vision, Robot Programming.

Embedded System: Overview of the Design Flow, Embedded Systems Specifications and Modeling, Embedded Hardware Platforms and Peripherals, Interfacing to the External World Through Sensors and Actuators.

References:

1. Modeling and Control of Robot Manipulator, Sciavicco and Siciliano, McGraw-Hill.
2. Introduction to Robotics: Mechanics and Control, John J. Craig, Pearson Prentice Hall.
3. Robot Analysis, 1st Edition, Lung-Wen Tsai, Wiley-Interscience
4. The 8051 Microcontroller and Embedded System, 2nd Edition, Muhammad Ali Majidi, Pearson.

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