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Cover Concept

Teachers, Department of Computer Science & Engineering

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Computer Compose

Firoz Mahmud, Assistant Professor (CSE)
Emrana Kabir Hashi, Lecturer (CSE)

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Address for Correspondence

Head
Department of Computer Science & Engineering
Rajshahi University of Engineering & Technology
Rajshahi-6204, Bangladesh.
Phone: +880-721-750838, +880-721-750742-43, Ext. 503
Fax: +880-721-750838
Departmental Office Phone: +880-721-750742-43, Ext. 501
www.cse.ruet.ac.bd

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Department of Computer Science & Engineering
Rajshahi University of Engineering & Technology
Rajshahi-6204, Bangladesh.

Contacts

The Head
Department of Computer Science & Engineering
Rajshahi University of Engineering & Technology
Rajshahi-6204, Bangladesh.
Phone: +880-721-750838, +880-721-750742-43, Ext. 503
Fax: +880-721-750838
Departmental Office Phone: +880-721-750742-43, Ext. 501
www.cse.ruet.ac.bd

Disclaimer

PREFACE

Rajshahi University of Engineering & Technology, abbreviated as RUET, is one of the most prestigious institution for higher studies in Bangladesh. It offers both undergraduate and post-graduate programs. The emphasis of this book is on the rules and regulations approved by the Academic Council of RUET subjected to students, teachers and advisors. The courses offered to students of this department as well as other basic courses are also presented in this book.

It is worth mentioning that the department of Computer Science & Engineering is committed to educate its students to think analytically and communicate effectively, train them to acquire technological, industrial and research oriented accepted skills, keep them abreast of the new trends and progress in the world of information & communication technology and inculcate in them the value of professional ethics.

The historical background of this university, facilities provided by the teaching departments, information regarding research and development and information about the university administration are also presented here. The students are advised to keep in touch with this book and also his/her course advisor so that they may be aware of any changes made by the authority.

Professor Dr. Md. Nazrul Islam mondal
Head
Department of Computer Science & Engineering
Rajshahi University of Engineering & Technology
Rajshahi-6204, Bangladesh.
July 2015.

CONTENTS

Introduction **Page no.**

History of the University 1
Location 1
The RUET Campus 1
Transportation 2
Faculties and Departments 2
Institute 3
Administrative Building 3
Laboratories 3
Facilities 4
Library 4
Student Health Service 4
Computer Center 4
Directorate of Student Welfare 4
The Central Students Union 5
Students Hall of Residences 5
Games and Sports Facilities 6
Auditorium Complex and Seminar Hall 6
Central Mosque 6
Cafeteria 6
RUET Administration 6

Department of Computer Science & Engineering

About the Department 7
Engineering Study track for Students 7
Excellent Prospects 8
List of Faculty Members 9
Laboratory Facilities of the Department 13
Consultancy, Research and Development 13

Computer Somity 14

Academic Ordinance for Undergraduate Studies 15

Syllabus

Summary of Undergraduate Course Plan 33
Courses Offered to the Undergraduate Students 33
Detail Syllabus 34

Academic Ordinance for Postgraduate Studies 45

Syllabus

Courses Offered to the Undergraduate Students 58
Detail Syllabus 60

Introduction

History of the University

Rajshahi University of Engineering & Technology, abbreviates as RUET, started functioning from September 2003, is one of the prominent and prestigious self-degrees awarding university in the engineering education of Bangladesh. It was founded in 1964 as a faculty of Engineering under the University of Rajshahi providing four years Bachelor degree in Civil, Electrical & Electronic and Mechanical Engineering. To circumvent the aforesaid problems several committees and commissions were formed since 1973. The consistent effort of these committees ultimately led to the establishment of four Engineering colleges to Bangladesh Institute of Technology (BIT) in July 1986. With a view to providing more opportunity and autonomy for the improvement in the quality of higher education and research in engineering and technology, the Institute was upgraded and renamed as Rajshahi University of Engineering & Technology in September 2003 und70er the "Rajshahi University of Engineering & Technology Act, 2003".

The university was financed by the Government through the university Grants Commission. The university is an autonomous statutory organization of the Government of Bangladesh functioning within the "Rajshahi University of Engineering & Technology Act, 2003". There are various statutory bodies like Syndicate, Academic Council, Finance Committee, Planning and Development Committees etc. for policy and decision making on different aspects of the university under the frame work of the Act.

Location

Rajshahi University of Engineering & Technology is situated at Kazla, five kilometers east of Rajshahi city and by the side of Rajshahi-Natore-Dhaka highway. The university campus extends over an area of 152 acres. Tastefully laid out with beautiful plantation, buildings of various nature and stature, clean and wide roads the campus present spectacle of harmony in architecture and natural beauty. The campus is laid out with picturesque landscape by the side of famous Padma river and Rajshahi University.

The RUET Campus

The Campus of RUET is remarkable for its natural beauty. It is well organize by many evergreen trees and roads. Mainly the campus area are divided into different functional zones: (i) Residence for students, (ii) Residential zones of faculty and other supporting staffs, (iii) Academic zone for academic buildings and laboratories/workshops, and (iv) Cultural cum social and recreational zones for students. A branch of Rupali Bank, a post office, an auditorium, a central mosque and a medical center are located on the campus. For the education of the children of the University employees, there is one school cum college. The shopping center

includes a branch of general stores, barber shop, photo copying facilities, restaurant and a big playing fields. The campus is fully residential providing comfortable social life.

Transportation

The university runs its own regular bus service to and from the city for benefit of the students residing there. This service helps the students to attend the classes at the morning without any delay. Besides, all kinds of mechanized transports carry out between the city and RUET as regular stoppage.

Faculties and Departments

RUET has four faculties and twelve Bachelor degree departments. At present undergraduate programs leading to Bachelor of Science in Engineering (B.Sc. Engg.), Bachelor of Urban & Regional Planning (BURP) and Bachelor of Architecture degrees are offered in twelve departments and postgraduate degrees (M. Sc./M Engg, M. Phil, and Ph. D) are being conferred by five departments.

Faculty of Electrical & Computer Engineering consists of the following departments

i. Department of Computer Science & Engineering (CSE)
ii. Department of Electrical & Electronic Engineering (EEE)
iii. Department of Electronic & Telecommunication Engineering (ETE)
iv. Department of Electrical & Computer Engineering (ECE)

Faculty of Civil Engineering consists of the following departments

i. Department of Civil Engineering (CE)
ii. Department of Urban & Regional Planning (URP)
iii. Department of Architecture (ARCH)

Faculty of Applied Science & Humanities consists of the following departments

i. Department of Chemistry
ii. Department of Humanities
iii. Department of Physics
iv. Department of Mathematics

Faculty of Mechanical Engineering consists of the following departments

i. Department of Mechanical Engineering (ME)
ii. Department of Industrial Production Engineering (IPE)
iii. Department of Mechatronics Engineering (MTE)
iv. Department of Glass & Ceramics Engineering (GCE)
v. Department of Chemical & Food Processing Engineering (CFPE)

Post graduate programs leading to Master of Science in Engineering (M. Sc. Engg.) or Master of Engineering (M. Engg.) and Ph. D degrees are offered in the following departments.

i. Department of Civil Engineering (CE)
ii. Department of Electrical & Electronic Engineering (EEE)
iii. Department of Mechanical Engineering (ME)
iv. Department of Computer Science & Engineering (CSE)
v. Department of Industrial Production Engineering (IPE)

M. Phil and Ph. D degrees are offered in the department of Mathematics, Chemistry, and Physics.

Institute

Institute of Information & Communication Technology.

Administrative Building

The administrative building of RUET is a three storied building. It situated in the central point of RUET campus. It accommodates the offices of Vice-Chancellor, Registrar and different offices. A branch of Rupali Bank and Post office are situated in this building. The laboratories of Physics and Chemistry departments are also situated in this building. At present the CSE department runs its three laboratories in the 2nd floor of this building. Some classes are also arranged in the 1st and 2nd floors.

Laboratories

Computer Science & Engineering Department has eight laboratories.

i. Artificial Intelligent & Robotics Lab
ii. Programming Lab
iii. Embedded System Lab
iv. Image Processing & GIS Lab
v. Algorithm Lab
vi. Networking Lab
vii. Operating System Lab
viii. Post Graduate Research Lab

Facilities

The University provides various educational and related facilities to build students with the ability to plan, administer and manage the latest technologies to decrease the gap between developed and developing countries. A brief description of them is given below.

Library

Central Library

There is an excellent central library in RUET. The library building is within the walking distance from the academic buildings and students residences. There are lot of facilities such as reading facility, borrowing of books, journals etc. to the students and teachers of RUET. In consistent with the academic curricula and development of

the world the contents of the library are updated consistently to keep up with modern technological trends.

Rental Library

To accelerate the library facility, each degree-awarding department has its own rental library that provides books on demand to the students for every semester.

Students Health Service

To provide primary and basic health care facilities to the students (residential and non-residential), employee and teachers there is an on campus medical center near to the central mosque. The health care facilities are totally free of charges. Three MBBS doctors and other staffs provide these facilities to the students. For specialized consultation on complicated cases, the center refers the patients to specialist consultants.

Central Computer Center

RUET has a central computer center providing computing and Internet facilities to the students and faculty members. It is equipped with high-configured PCs and Network Servers, and Printing and Data storage facilities. The center often offers short training courses to skill oneself.

CISCO Networking Academy

CISCO networking academy, RUET offers four semesters CISCO course in Computer Science & Engineering Department at RUET.

Directorate of Student Welfare

The Directorate of Student Welfare (DSW) is responsible for the various activities related to the physical, social and other aspects of the student's welfare. The DSW monitor the supervision for halls of residence, programs for physical education, games and sports, supervision of the programs of co-curricular activities of students through the Central Student Union and through the students union of the various halls of residence. It is also responsible for providing health services through the student's health center.

The Central Students Union

The students have their own Central Students Union for their welfare. Most of its members are elected by the students, maintains and aids the new students in their introduction to the RUET as well as in looking after the problems of the students.

The student unions also arrange their individual co-curricular activities, literary competitions, local computer-programming contest, IT quizzes. The union also takes active part for the proper management of the hall administration.

Students Hall of Residences

There are six halls of residence at RUET campus. The total capacity of these halls is about 1550. Name of the halls with their respective capacities are depicted in the table bellow. Some of the halls are named after the national hero who sacrificed their lives in the liberation war of Bangladesh in 1971.

The existing capacity is around 70% of the total number of students of RUET. Non-residential students are to be attached with a hall so that the administrative control on the students becomes hall based.

Residential Halls of RUET

Serial No.	Name of the Halls	Residential Capacity
1.	Shahid Lt. Selim Hall	350
2.	Shahid Shahidul Islam Hall	225
3.	Shahid Abdul Hamid Hall	225
4.	Tin Shed Hall (Extension)	100
5.	Deshrotno Sheikh Hasina Hall	248
6.	Bangabandhu Sheikh Mujibur Rahman Hall	200
7.	Shahid President Ziaur Rahman Hall	480

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

Games and Sports Facilities

RUET has a modern sports center, which provides excellent facilities to students for acquiring physical fitness that is indispensable for a healthy mind and body. The University has a beautiful playground, tennis lawn and basketball court. The sports center arranges a colorful athletic competition every year in the form of annual sports competition.

The University arranges inter-year, inter-departmental football, cricket, basket ball, badminton, volleyball competition and also various indoor games. Teacher student friendly games are also arranged during some special occasions.

Auditorium Complex and Seminar Hall

The University has an excellent Auditorium Complex with modern facilities having a seating capacity of about 700 audiences, which is capable of holding conferences, seminars and other cultural programs. Besides this, there are individual seminar and conference rooms in each engineering degree awarding departments.

Central Mosque

The central mosque of Rajshahi University of Engineering and Technology is situated within the walking distance of teachers and staffs quarters as well as the

student's residential halls. All the religious Muslims take their prayer here without having any difficulty. The building is under reconstruction considering its existing limited capacity.

Cafeteria

The central cafeteria is under construction near the main gate of RUET. It is within the walking distance from the academic and administrative building. Students, Teachers and the Staffs can get refreshment easily from the cafeteria with cheap rate.

RUET Administration

RUET administration is governed by the rules and statues framed in the University ordinance 2003. On the recommendation of Academic Council and various committees as mentioned in the ordinance, the Syndicate approves the policies and operational procedures of the University. The Vice Chancellor is the administrative head of the University.

Chancellor

Honorable President Md. Abdul Hamid

Vice Chancellor

Professor Dr. Mohd. Rafiqul Alam Beg

Registrar

Prof. Dr. Md. Mosharraf Hossain

Department of Computer Science & Engineering

About the Department

Department of Computer Science & Engineering includes twenty eight faculty members, thirteen staff members, five hundred and forty undergraduate students (60 graduates per year). It is ranked highly among all the departments of Rajshahi University of Engineering & Technology. We are active in most of the principal areas of the field, and are engaged in a broad range of interdisciplinary initiatives. Computer Science is the discipline that studies the structure, function, and applications of computers as well as the interconnection of computers. Covering topics in the areas of foundations of computer science and computer engineering, artificial intelligence, networking, computer graphics, multimedia computing, software and web technologies, and data and knowledge-base systems, the Computer Science & Engineering programs at this University are dedicated to educate students and to advance research in computer and information technology; as well as to assist in the development and growth of the information industry in the region.

The Department offers a full range of courses to meet the needs of its own students and those from other departments. Its programs lead to the B. Sc. Engg. degree. Aside from taking computer science courses, students are encouraged to design individual study plans tailored to their own interests.

There is no question that the Bachelor degree in computing takes hard work and is not for everyone. The work, however, pays off. Programming jobs are increasing in number, the overall job market in computing has been better than the national average throughout the last six years. Excluding health care, Garments sector, Industries more than twice as many new jobs are forecast in computing as in the life and physical sciences and engineering combined.

Further, the ability to build the new economy is easier in software than anything else one can set up shop in an office and be generating revenue in short order.

We are located in the spectacular newly build building which is beside the auditorium and the department of Electrical & Electronics Engineering. The departmental events include student defenses, seminars, lectures, research presentations, study tour, fresher orientation, yearly sports competition, debate and other student events.

Engineering Study Track for Students

The department offers an exciting and challenging opportunity for elite students. Privileges and benefits include studying alongside a small group of elite students, closer interaction with teachers that result in interactive class teaching, as well as the opportunity to earn a Bachelor's degree in four years.

The Department of Computer Science and Engineering at RUET has a multicultural student's environment, in particular, students coming from the South Asia like India and Nepal, help our students prepare well for the globalization trend. Our

department is recognized by all the reputed organization, in terms of research record and Skills, Programming Competition and various educational programs

The department has a Seminar library room with various journals that provides excellent opportunities for research. Books are provided to the students on demand basis for each semester from the rental library. Students are encouraged for academic excellence by awarding prizes, medals and certificates for year wise performance. An official award named as *"Joynal Memorial Award"* is also given to the student who obtains the highest grade point amongst the second year students of all disciplines. Different organizations and other people of various disciplines are being trained time to time with computer literacy by the department.

B. Sc. Engg. in Computer Science & Engineering

- Degree Award: B.Sc.Engg
- Total Credit: 158.00-162.00
- Abbreviated Title: CSE
- Program Duration: Four Academic Years with Eight Semesters (Full-time)

Computer science & Engineering studies the application of computers in solving many important problems in scientific, engineering and commercial domains. Our general undergraduate degree program provides a broad education in all core areas of Computer Science & Engineering, while allowing students the flexibility to pursue individual interests in higher-level areas. The core areas include programming, data structures and algorithms, operating systems and software engineering, database, networking, systems software, computer graphics, image processing, medical imaging, artificial intelligence, computer vision, computer security, and theoretical computer science.

Excellent Prospects

About 15-20% of our graduates pursue postgraduate study immediately upon graduation in various universities in Bangladesh. While many of them go abroad to study at top universities all over the world, particular in Canada, Australia, Germany, Finland, Sweden, USA, Thailand, Hong Kong to take up research opportunities.

Our graduates are usually successful in entering the profession of their choice. Some join famous computing-related & mobile companies like Apple, Twinmos, Siemens, Motorola, Grameen Phone, Banglalink, Aktel, Citicell while others prefer different fields, particularly in the Software and Network sector.

List of Faculty Members

Academic Staffs

Prof. Dr. Md. Shahid Uz Zaman
Ph. D., University of Ryukyus, Japan
M. Sc. Engg., University of Shanghai, China
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: GIS-based Mapping, VRPs and Satellite Imaging, Database Management System and Algorithms

Prof. Dr. Md. Nazrul Islam Mondal
Ph. D., Hiroshima University, Japan
M. Sc. Engg., Asian Institute of Technology, Thailand
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: FPGA-based Reconfigurable Computing, Parallel Computing, Mobile Computing, Algorithms and Architectures, Image Processing, Digital Signal Processing, Computer Networks and Data Communications

Prof. Dr. Md. Rabiul Islam
Ph. D., RUET, Bangladesh
M. Sc. Engg., RUET, Bangladesh
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Biometric Security, Pattern Recognition, Audio-Visual Speaker Identification, Speech and Speaker Recognition, Artificial Intelligence, Face Recognition, Image and Signal Processing.

Dr. Boshir Ahmed
Associate Professor
Ph. D., RUET, Bangladesh
M. Sc. Engg., RUET, Bangladesh
B. Sc. Engg., DUET, Bangladesh
Field of Specialization: Digital Image Processing specially Satellite Image, Remote Sensing, Digital Signal Processing, Data Communication, Computer Networks, Digital/Analog Circuit Design, Microprocessor Based System Design

Dr. Md. Al Mamun
Associate Professor
Ph. D., University of New South Wales, Australia
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Satellite Image Mining: Image Compression, Change Detection, Prediction and Forecasting, Adaptive Linear and Non-linear Modelling, Remote Sensed Image Interpretation and Symbolic Representation of Image Contents, Visualization and Model Generation for Handling Complex Data Set. Computer Vision: Pattern Recognition and Image Classification, Objects Recognition. Feature Extraction and Nonlinear Image Classification

Dr. A H M Sarowar Sattar

Assistant Professor
Ph. D., University of South Australia, Australia
M. Sc. Engg., The Royal Institute of Technology, Sweden
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Data mining, Data Privacy, Information & Communication Security, Network Security

Mir Md. Jahangir Kabir

Assistant Professor
M. Sc. Engg., University of Stuttgart, Germany
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Evolutionary Algorithm, Optimization, Data mining, Artificial Intelligence, Machine learning

Firoz Mahmud

Assistant Professor
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Computer vision: Imaging, Robotics, Signal Processing, Machine Learning, Data Mining, Computational Non-Cooperative and Deceptive

Rizoan Toufiq

Assistant Professor
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Machine Learning, Data Mining, Classifier Fusion Technique, Bioinformatics, Pattern Recognition, Neural Network & Fuzzy System, Genetic Algorithm, Image Processing, Evolutionary Optimization and Artificial Intelligence, Web Engineering, Security and Privacy.

Biprodip pal

Assistant Professor
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Artificial Intelligence: Machine Learning, Neural Networks & Deep Learning, Kernel Based Learning, Transfer Learning, Reinforcement Learning, Statistical Data Mining & Knowledge Discovery
Applications: Social Network Mining, Web Mining/Intelligent Web, Recommendation Systems, Business Intelligence

Julia Rahman

Assistant Professor
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Bioinformatics, Machine Learning, Wireless Sensor Network

Shyla Afroge

Assistant Professor
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Machine Learning, Image Processing, Bio-informatics, Data Mining, Pattern Recognition

Dr. Ashek Ahmmed

Lecturer
Ph. D., University of New South Wales, Australia
M. Engg., Politecnico di Milano, Italy
B. Sc. Engg., KUET, Bangladesh
Field of Specialization: Statistical signal processing backed by the principles of information theory and Machine learning.

Dr. Md. Ali Hossain

Lecturer
Ph. D., University of New South Wales, Australia
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Remote Sensing and Satellite Image Processing, Feature Extraction and Image Classification, Manifold learning and Kernel Modeling

Emrana Kabir Hashi

Lecturer
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: GIS, Graph Theory, Data mining, Machine learning

Mumu Aktar

Lecturer
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Machine learning, Data mining, Image processing, GIS

Barshon Sen
Lecturer
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Machine Learning, Biometrics, Data Mining, Neural Networks & Fuzzy System, Pattern Recognition, Image Processing.

Shafika Showkat Moni
Lecturer
B. Sc. Engg., RUET, Bangladesh
Field of Specialization:: Wireless Sensor Network, Cooperative Communication, Mobile Adhoc Network

Sadia Zaman Mishu
Lecturer
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Bio-informatics, Neural Network, Machine learning, Data mining

Abu Sayeed
Lecturer
B. Sc. Engg., RUET, Bangladesh
Field of Specialization: Biometrics, Gait, Neural Network, Big Data

Academic Staffs (On Study Leave):
Assistant Professor
Dr. Md. Waselul Haque Sadid
Abul Ahsan Md. Mahmudul Haque
Md. Murad Hossain
Md. Al Mehedi Hasan
Sayed Tauhid Zuhori
Md. Arafat Hossain
Lecturer
Shubhashis Kumar Shil
Md. Hedayetul Islam Shovon

Technical Staffs

1. Md. Kalimuzzaman — System Analyst
   B. Sc. Engg., KUET, Bangladesh
2. Md. Shihan Arefin — Programmer
   B. Sc. Engg., RUET, Bangladesh
3. Mahmudur Rahman Khan — Technical Officer

Laboratory Facilities of the Department

The department provides adequate laboratory, library and other facilities to the students and researcher. The departmental undergraduate courses are laboratory intensive and this requirement is catered by the following laboratories at present.

i) Artificial Intelligent & Robotics Lab
ii) Programming Lab
iii) Embedded System Lab
iv) Image Processing & GIS Lab
v) Algorithm Lab
vi) Networking Lab
vii) Operating System Lab
viii) Post Graduate Research Lab

Students in first and second year have to undertake laboratory/Sessional classes in Physics, Chemistry and Electrical Engineering and in different workshops.

Consultancy, Research and Development

Another significant part of the department activities is advisory and consultancy services including research and development work for some organizations of national importance. These services are regularly offered by the department and are considered to be of great help by the clients. These types of activities provide the teachers the opportunities to gain some valuable experience. Such interaction between different departments of the University and the organization extends the role of the University in the national development. The Department of Computer Science and Engineering has established critical mass in a few research areas for undergraduate theses and projects that are relevant to the needs of society that can sustain by talents from the local community. Some of these areas are:

Theoretical Computer Science (TH)

Work in the *Theoretical Computer Science* tries to model central problems from computing applications, find efficient approaches to solving them, and identify structures that underlie computational processes. Solutions are typically, but not always, independent of specific hardware and software architectures. Solutions may involve more modeling than algorithms, more algorithms than performance analysis, or more data structure issues than algorithmic ones.

Artificial Intelligence (AI)

Artificial intelligence research studies how computers can be made to exhibit intelligent behavior in performing certain tasks, which, at the moment, are often done better by human beings. These tasks include speech and language processing, vision, motion control, reasoning, planning, decision-making, and learning.

Data, Knowledge and Information Management (DB)

Research in *Data, Knowledge and Information Management* draws upon techniques from the database, knowledge base, information retrieval, software engineering and networking areas and focuses primarily on the effective integration and application of technologies from these areas. It is driven by the need of existing and emerging data-, knowledge- and information-intensive applications in both centralized and distributed environments.

Networking and Computer Systems (NE)

Faculty members in *Networking and Computer Systems* are conducting cutting edge research that is at the heart of the Information Technology revolution. Their research covers wide and well-integrated topics that can be classified as follows: networking equipment, networking applications, networking protocols and networking security.

Software Technologies (ST)

Software Technologies are pervasive in that virtually all applications involving the digital computer require software to make the hardware components function properly. They can be modified more easily than hardware to adapt to changes in applications or to support additional features. Research in this area includes computer music, cryptography and security, internet computing and software engineering.

Vision and Graphics (VG)

The *Vision and Graphics* group leads research in image analysis, computer vision and computer graphics. Computer Vision and Image Analysis focuses on the challenge of making computers see and understand images while Computer Graphics focuses on the challenge of making computers create pictures. The major research areas under investigation include computer vision, computer graphics, medical image, biometric systems and video processing.

Computer Science is still a young field. We move from explicit interactions with disconnected computing devices to implicit and pervasive interactions with highly interconnected, integrated digital resources embedded in the environments in which we work, live, learn, and play. The impact of computer science & engineering will be broad and deep. Computer Science & Engineering at RUET prepare students for exciting challenges and new opportunities that help to bring such impact to our lives.

Computer Somity

To facilitate academic and extra-academic activities of the students & teachers of the department there is a 'Computer Somity' consisting of class representatives who are elected by the students themselves. The Association works under the direct supervision and guidance of the Head of the Department. The major source of the Association fund is contribution made by the department students and the teachers. The head of the department nominates one faculty member to act as honorary treasurer of the association.

Academic Ordinance for Undergraduate Studies for the Award of Bachelor of Science in Engineering Degree

1. Definitions:

1.1 'University' means the Rajshahi University of Engineering & Technology abbreviated as RUET.
1.2 'Syndicate' means Syndicate of RUET.
1.3 'Academic Council' means the Academic Council of the University.
1.4 'Deans Committee' means the Executive Committee of concerned Faculty of the University.
1.5 'Academic Committee' means the Academic Committee for Undergraduate Studies of Department of the University.
1.6 'Vice-Chancellor' means the Vice-Chancellor of the University.
1.7 'Dean' means the Dean of the Faculty of the University.
1.8 'Head of the Department' means the Head of a Department of the University.
1.9 'Central Equivalence Committee' means the Central Equivalence Committee of the University.
1.10 'Degree' means the degree of Bachelor of Science in Engineering or Bachelor of Urban & Regional Planning or Bachelor of Architecture offered by the University.
1.11 'Course System' means pass or fail on course basis.
1.12 'Backlog Courses' means the failed courses after appearing at odd/even semester(s) examination.
1.13 'Short Semester' means a semester for conducting classes and examinations of Backlog course(s) at the end of 4th /5th year Backlog examination result.

2. Faculties:

The University has four Faculties:
(1) Faculty of Civil Engineering (CE)
(2) Faculty of Electrical & Computer Engineering (ECE)
(3) Faculty of Mechanical Engineering (ME)
(4) Faculty of Applied Science & Humanities (ASH)

2.1 Degree Awarding Departments:

The University has the following Degree Awarding Departments under four Faculties:

i) Department of Civil Engineering (CE)
ii) Department of Electrical & Electronic Engineering (EEE)
iii) Department of Mechanical Engineering (ME)
iv) Department of Computer Science & Engineering (CSE)
v) Department of Electronic and Telecommunication Engineering (ETE)
vi) Department of Industrial and Production Engineering (IPE)
vii) Department of Glass & Ceramic Engineering (GCE)
viii) Department of Urban & Regional Planning (URP)
ix) Department of Mechatronics Engineering (MTE)
x) Department of Architecture (ARCH)
xi) Department of Chemical & Food Processing Engineering (CFPE)
xii) Department of Electrical & Computer Engineering (ECE)
xiii) Any other Department to be instituted by the Syndicate on the recommendation of the Academic Council.

2.2 Teaching Departments:

The University has the following teaching departments as defined in the statutes:

i) Department of Civil Engineering
ii) Department of Electrical & Electronic Engineering
iii) Department of Mechanical Engineering
iv) Department of Computer Science & Engineering
v) Department of Electronic and Telecommunication Engineering
vi) Department of Industrial and Production Engineering
vii) Department of Glass & Ceramic Engineering
viii) Department of Urban & Regional Planning
ix) Department of Mechatronics Engineering
x) Department of Architecture
xi) Department of Chemical & Food Processing Engineering
xii) Department of Electrical & Computer Engineering
xiii) Department of Mathematics
xiv) Department of Physics
xv) Department of Chemistry
xvi) Department of Humanities
xvii) Any other Department to be instituted by the Syndicate on the recommendation of the Academic Council.

3. Degrees Offered:

The University offers courses leading to the award of the following degrees:

i) Bachelor of Science in Civil Engineering abbreviated as B.Sc. Engg. (CE)
ii) Bachelor of Science in Electrical & Electronic Engineering abbreviated as B.Sc. Engg. (EEE)
iii) Bachelor of Science in Mechanical Engineering abbreviated as B.Sc. Engg. (ME)
iv) Bachelor of Science in Computer Science & Engineering abbreviated as B.Sc. Engg. (CSE)
v) Bachelor of Science in Electronic & Telecommunication Engineering abbreviated as B.Sc. Engg. (ETE)
vi) Bachelor of Science in Industrial and Production Engineering abbreviated as B.Sc. Engg. (IPE)
vii) Bachelor of Science in Glass & Ceramic Engineering abbreviated as B.Sc. Engg. (GCE)
viii) Bachelor in Urban & Regional Planning abbreviated as BURP.
ix) Bachelor of Science in Mechatronics Engineering abbreviated as B.Sc. Engg. (MTE)
x) Bachelor in Architecture abbreviated as B. ARCH.
xi) Bachelor of Science in Chemical & Food Processing Engineering abbreviated as B.Sc. Engg. (CFPE)
xii) Bachelor of Science in Electrical & Computer Engineering abbreviated as B.Sc. Engg. (ECE)
xiii) Any other degree that may be awarded by any department on the approval of the syndicate on the recommendation of the Academic council.

4. Student Admission, Equivalence and Admission Transfer:

4.1 The four academic years of study for the Bachelor degree have been designated as 1st year class, 2nd year class, 3rd year class and 4th year class in succeeding higher levels of study. For Architecture, five years of study for the Bachelor degree have been designated as 1st year class, 2nd year class, 3rd year class, 4th year class and 5th year class in succeeding higher levels of study.
Students shall be admitted into the 1st year class.

4.2 The Academic Council will form an Admission Committee in each academic session for admission into 1st year Bachelor Degree class.

4.3 A candidate for admission into the 1st year class must have passed the H.S.C Examination from a Secondary and Higher Secondary Education Board in Bangladesh (after 12 years of schooling) with Physics, Chemistry, Mathematics and English as his/her subjects of Examination in Higher Secondary level or examination recognized as equivalent thereto, and must also fulfill all other requirements as prescribed by the Academic Council on the recommendation of the Admission Committee. In case of confusion regarding the equivalence, the case may be referred to Equivalence Committee.

4.4 All candidates for admission into the courses of Bachelor Degree must be the citizens of Bangladesh. Candidates for all seats except the reserved (Tribal) ones, if any, are selected on the basis of merit. However, all candidates must pass the required level as set by the admission committee. The Academic Council, on the recommendation of the Admission Committee, frames the rules for admission into the reserved seats.

4.5 No student ordinarily is admitted in the 1st year class after the corresponding classes start or after the call goes out for admission into the next session, whichever is earlier.

4.6 Admission of a newly admitted student in the 1st year class is canceled if he/she fails to attend any class within the first two consecutive cycles after the start of class without prior permission. The date of commencement of classes for the newly admitted students will be announced in advance.

4.7 An Equivalence Committee consisting of at least five members will be formed by the Academic Council in order to consider the equivalence of different public examinations.

4.8 A candidate, seeking admission on transfer from other University, should apply to the Registrar of the University if there is any exchange program with that university. The Registrar will refer the case to the concerned Head of the Department and also to the Equivalence Committee. On receiving the opinions of the Head of the Department and of the Equivalence Committee, the matter will be forwarded to the Academic Council. The Academic Council's decision will be communicated to the Head of the Department and the candidate.

4.9 There is no transfer in the 1st year class. In special cases, students may be admitted into a higher class under clause 4.8.

4.10 Every student being admitted to the University shall be examined by a competent medical officer as prescribed in the admission rules.

5. Method of Course Offering and Instruction:

The undergraduate curricula at RUET are based on course system. The salient features of course system is:

i) Number of theoretical courses and examination papers shall be five in each semester.
ii) Continuous evaluation of student's performance.
iii) The flexibility to allow the student to progress at his/her own pace depending on his/her ability or convenience, subject to the regulations on credit and minimum grade point average (GPA) requirements.
iv) Promotion of teacher-student contact.

6. Academic Calendar:

6.1 The academic year is ordinarily divided into two semesters each having duration of not less than 13 cycles.

6.2 There are final examinations at the end of each semester conducted by the respective degree awarding departments of the University.

6.3 On the approval of the Academic Council an academic schedule for the year will be announced for general notification before the start of the academic year. The schedule may be prepared according to the following guidelines:

Odd Semester	**Duration**
Classes	13 cycles
Mid-semester recess	1 week
Recess before examination and Semester Final Examination	29 days
Inter-Semester Recess	1 weeks
Even Semester	**Duration**
Classes	13 cycles
Mid-semester recess	1 week
Recess before examination and Semester Final Examination	29 days
Inter-Year Recess, Result publication, and Preparation for next semester	3 weeks
Backlog Examination	2 Weeks
Result publication	1 Weeks
Vacation and others	Rest
Total	52 Weeks
Short Semester	**Duration**
Classes and Examinations	10 Weeks

7. Duration of Course and Course Structure:

7.1 Bachelor Degree courses (except Architecture) extend over a period of four academic years (8 semesters), each of a normal duration of one calendar year, which is divided as necessary for the purpose of academic program and conduct

of examinations. For Bachelor degree in Architecture, the period will be five academic years (10 Semesters).

7.2 The curricula of the Bachelor degree in the different departments are as proposed by the respective Academic and Dean's Committee and approved by the Syndicate on the recommendation of the Academic Council.

7.3 The Academic Committee reviews the curricula as required and put forward suggestions to the Academic Council through Dean's Committee.

7.4 Teaching for the courses is reckoned in credits and the credits allotted to various courses are determined by the Academic Committee with the following guidelines:

Nature of Course	Contact hour	No. of Credit
i) Theory	1 hour/week	1
ii) Tutorial	1 hour/week	1
iii) Independent sessional/design	3/2 hours/week 2 hours/week 3 hours/week and similar	0.75 1 1.5
iv) Project & thesis	3 hours/week and similar	1.5
v) Field work	2-4 weeks of field work	1

7.5 The total number of credits that a student has to complete successfully for the award of Bachelor degree is minimum 160 except for Bachelor in Architecture. The maximum period of candidature is seven years, i.e., 3 years (6 semesters) more than the normal time required to complete the course. For Architecture the minimum credit will be 200.

7.6 The total number of credits per week in a semester shall be as approved curricula.

7.7 The total contact hours for students including lecture, tutorial and sessional is around 25 (35 for Architecture) periods per week, each period being of minimum 50 minutes duration.

7.8 In each degree-awarding department, one of the senior teachers nominated by the Head of the Department acts as Course Coordinator who acts as Member Secretary to the academic committee.

7.9 A course plan for each course, approved by the Course Coordinator, showing details of lectures may be announced at the start of each semester.

7.10 Credits in any theory subject do not exceed 4 and that in sessional subject do not exceed 3.0. For Architecture credits in sessional subject will not exceed 12.0.

8. Course Designation and Numbering System:

Each course is designated by a three to four letter word identifying the department, which offers it following, by a three-digit number with the following criteria:

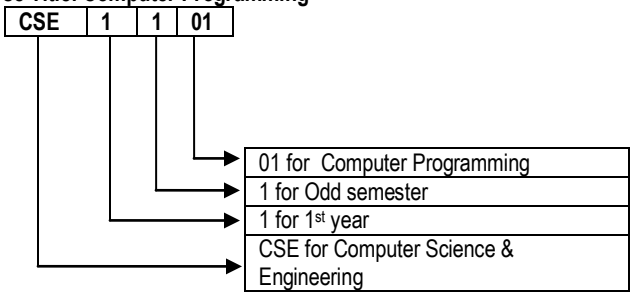
a) The first digit corresponds to the semester in which the course is normally taken by the students.

b) The 2nd and 3rd digits are reserved for departmental use indicating major area.

The course designation system is illustrated by one example as shown below:

Course No. CSE 1101

Course Title: Computer Programming



9. Types of Courses:

The courses included in undergraduate curricula are divided into several groups as follows:

9.1 **Core Courses:** In each discipline a number of courses are identified as core courses which form the nucleus of the respective Bachelor's degree program. A student has to complete all of the designated core courses for his discipline.

9.2 **Pre-requisite Course:** Some of the core courses are identified as pre-requisite courses. A pre-requisite course is one, which is required to be completed before taking some other course(s). Any such course, on which one or more subsequent courses build up, may be offered in each of the two regular semesters (if possible).

9.3 **Optional Courses:** Apart from the core courses, students have to complete a number of courses which are optional in nature. In those cases, students will have some choices to choose the required number of courses from a specified group/number of courses.

10. Departmental Monitoring Committee and Student Adviser:

10.1 **Department monitoring committee:** Each department constitutes a Departmental Monitoring Committee with two teachers from the respective Department as members, nominated by the Academic Committee and Head of the Department as chairman. This committee monitors and evaluates the performance of the Course System within the Department. The committee may

also propose from time to time to the Academic Committee if any changes and modifications needed for upgrading/changing the Undergraduate Curriculum and the Course System.

10.2 **Student Adviser:** One adviser is appointed for a batch of student (around 30) by the Department Monitoring Committee of the concerned Department(s) who advises each student on the courses to be taken by a student. Adviser discusses with the student on his academic program and then decides the nature of courses for which he/she can register. However, it is the student's responsibility to keep contact with his adviser who reviews and eventually approves the student's specific plan of study and checks on subsequent progress. The adviser generally be of the rank of an Assistant Professor or above from the concerned Department(s). However, in case of shortage of teachers, Lecturers may be appointed as adviser.

For a student of second and subsequent semesters, the nature of courses for which he can register will be decided on the basis of his/her academic performance during the previous semester(s). The adviser advises the students to register for the courses during the next semester within the framework of the guidelines in respect of minimum/maximum credit hours limits.

11. Registration Requirements:

Any student who wants to study a course is required to register formally. Being admitted to the University, each student is assigned to a student adviser. The student can register for courses he/she intends to take during a given semester only on the basis of the advice and consent of his/her adviser.

11.1 **Registration Procedure:** Students must register for each class in which they will participate. Each student will fill up his/her Course Registration Form in consultation with and under the guidance of his/her adviser. The original copy of the Course Registration Form(s) will be submitted to the Registrar's Office, and then the requisite number of copies will be distributed to the adviser and Head. The date, time and venue for registration will be announced in advance by the Department's Office. It is absolutely necessary that all students present themselves for registration at the specified time.

11.2 **Limits on the Credit Hours to be taken:** A student must be enrolled for the requisite number of credits as mentioned in article 7.6. A student must enroll for the prescribed sessional courses in the respective semester within the allowed credit limits.

11.3 **Pre-condition for Registration:** A student will be allowed to register in those courses subject to the satisfaction of pre-requisite courses. If a student fails in a pre-requisite course in any semester, the concerned Department Monitoring Committee may allow him/her to register for a course which builds on the pre-requisite course provided his attendance and grades in continuous assessment in the said pre-requisite course is found to be satisfactory.

Registration will be done at the beginning of each semester. Late registration is however, permitted during the second week on payment of a late registration fee. Students having outstanding dues to the University or a hall of residence shall not be permitted to register. All students have therefore, to clear their dues and get a clearance or no dues certificate, on the production of which, they will be given necessary Course Registration Forms and complete the course registration procedure. Registration Forms are normally available in the Register's office. An orientation program will be conducted for only the first year students at the beginning of the first semester when they will be handed over the registration package on producing enrollment slip/proof of admission.

11.4 **Registration Deadline:** Student must register for the courses to be taken within 1 (One) cycle from the commencement of each semester and no late registration will be accepted after 2(Two) cycles of classes. Late registration after this date will not be accepted unless the student submits a written appeal to the Registrar through the concerned Head and can document extraordinary circumstances such as medical problems (physically incapacitated and not able to be presented) or some other academic commitments which precluded enrolling prior to the last date of registration.

11.5 **Penalty for Late Registration:** Students who fail to register during the designated dates for registration are charged a late registration fee Tk 500/= per cycle. This extra fee will not be waived whatever be the reason for late registration.

11.6 **Withdrawal from a Semester:** If a student is unable to complete the semester Final Examination due to illness, accident or any other valid reason etc., he/she may apply to the Head of the department. Each Department will decide for total withdrawal from the semester before the start of the semester final examination. He/she may choose not to withdraw any laboratory/sessional/design course if the grade obtained in such a course is 'D' or better. The application must be supported by a medical certificate from any authorized Medical Officer. The Academic Council will take the final decision about such applications. However he/she will not be permitted to the next year class unless he/she completes the required credit for that year.

12. Striking off the Names and Readmission:

12.1.1 The names of the students shall be struck off and removed from the rolls on the following grounds:

i) Non-payment of University fees and dues within the prescribed period.
ii) Forced to discontinue his/her studies under disciplinary rules.
iii) Withdrawal of names from the rolls of the University on grounds acceptable to the Vice-Chancellor of the University/ nominated authority after having cleared all dues.
iv) Could not earn required credits for graduation as outlined in the respective curriculum and/or fulfill CGPA requirement within the maximum allowed time of 7 academic years. For Architecture maximum allowed time is 8 academic years.

12.2 Every student whose name has been struck off the rolls by exercise of the clauses (ii) of Article 12.1 seeking re-admission after expiry of the period for which he/she was forced to discontinue his/her studies, shall submit an application to the Head of the Department in the prescribed form before the commencement of the session to which he/she seeks re-admission. The Head of the Department shall forward the application to the Registrar of the University with his remarks. In case the readmission is allowed, the student will be required on payment of all dues to get him/her-self admitted no later than one week from the date of permission given by the Registrar. All readmission should preferably be completed before the session starts. The percentage of attendance of the re-admitted students shall be counted from the date of recommendation of the concerned Head of the department.

12.3 No student who has withdrawn his/her name under clause (iii) of Article 12.1 shall be given readmission.

12.4 In case, a student whose name has been struck off the rolls under clause (i) of Article 12.1 seeks readmission within the session in which his/her name was struck off, he/she shall be readmitted on payment of all the arrears fees and dues. But if he/she seeks readmission in any subsequent session, the procedure for his/her readmission will be the same as described under Article 12.2.

12.5 The application of a student for readmission will be considered if he/she applies within two academic sessions from the semester of discontinuance of his/her studies in the University. Other than debarment as punishment under the ordinance related to discipline, a student failing for any other reason whatsoever to become a candidate for a semester final examination in which he/she ought to have had in the usual process of his/her progressive academic activities, shall be considered to have discontinued his/her studies for the relevant semester together with striking the name off from current roll and two such discontinuance periods will be considered equivalent to that for one academic session. The maximum period of discontinuance under no circumstances is to exceed two academic sessions during a student's period of studies for the degree.

12.6 In case any application for readmission is rejected, the student may appeal to the Academic Council and, in this case, the decision of the Academic Council shall be final.

12.7 A student, whose name has been struck off the rolls by exercise of clause (iv) of Article 12.1, is not eligible to seek readmission.

12.8 After Short semester, if any student fails to complete his/her required courses he/she will take readmission in the final year.

13. Grading System:

The letter grade system shall be used to assess the performance of the student and shall be as follows:

Numerical grade	Letter grade	Grade point
80% or above	A+ (A Plus)	4.0
75% to less than 80%	A (A Regular)	3.75
70% to less than 75%	A- (A Minus)	3.5
65% to less than 70%	B+ (B Plus)	3.25
60% to less than 65%	B (B Regular)	3.0
55% to less than 60%	B- (B Minus)	2.75
50% to less than 55%	C+ (C Plus)	2.5
45% to less than 50%	C (C Regular)	2.25
40% to less than 45%	D	2.0
Less than 40%	F	0
Incomplete	**I**	**-**
Need--------	**X**	**-**

A grade 'I' shall be awarded for courses (like project & thesis, design etc.) in the odd semester, which continue through to the even semester.

13.1 **Calculation of GPA and CGPA:** Grade point average (GPA) is the weighted average of the grade points obtained in all the courses passed/completed by a student in a semester. 'F' grades do not count for GPA calculation. GPA of a semester will be calculated as follows:

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

where, n is the total number of courses passed by the student, C_i is the number of credits allotted to a particular course i and G_i is the grade point corresponding to the grade awarded for i-th course.

The overall or Cumulative Grade Point Average (CGPA) gives the cumulative performance of the student from first semester up to any other semester to which it refers and is computed by dividing the total grade points ($\Sigma C_i G_i$) accumulated up to the date by the total credit hours (ΣC_i). Both GPA and CGPA are rounded off to the second place of decimal for reporting.

14. Distribution of Marks:

14.1 **The distribution of marks for a given course is as follows:**

i) **Theory courses:**

Class participation and attendance	08
Class tests	20
Semester Final Examination (3 hours duration)	*72*
Total	100

ii) **Independent sessional/design/field work courses:**

Class participation and attendance	08
Quizzes/viva voce	20
Board Viva (Compulsory)	25
Performance/reports	*47*
Total	100

iii) **Project and thesis (Architecture):**

Class participation and attendance	10
Internal criticisms	40
Viva voce/ Jury	30
Supervisor (Internal Examiner	*20*
Total	100

iv) **Project and thesis (Other departments):**

Viva voce (conducted by a viva voce committee)	30
Supervisor (internal examiner)	50
External examiner (any other teacher of the department/ Examination committee)	20
Total	100

14.2 Basis for awarding marks for class participation and attendance will be as follows:

Attendance	**Marks**
90% and above	8
85% to less than 90%	7
80% to less than 85%	6
70% to less than 80%	5
60% to less than 70%	4
Less than 60%	0

14.3 The students will not be allowed to sit in the semester final examination for failing to attend at least 50% in the classes. The students whose percentage of attendance will fall short of 75% in any of the theory, sessional courses for which he/she has registered in one academic year shall not be eligible for the award of any type of scholarship/stipend/grant for the following academic session.

15. Class tests:

i) 3 best out of 4 class tests may be taken for awarding grade.

ii) Duration of class tests normally should be 20-30 minutes and materials covered should be what were taught in 2 to 3 previous cycles or most recent classes.

iii) The dates for the class tests shall be fixed by the Head or Course Coordinator and dates shall be announced accordingly.

iv) All class tests shall ordinarily be of equal value. The result of each individual class test shall be posted for information of the students preferably before the next class test is held.

16. Earned Credits:

The courses in which a student has obtained 'D' or a higher Grade will be counted as credits earned by him/her. Any course in which a student has obtained 'F' grade will not be counted towards his/her earned credits.

A student, who obtains a 'F' grade in any Core Course in any semester, he/she will have to repeat the course. If a student obtains a 'F' in an Optional Course, he/she may choose to repeat the course or take a substitute course if available.

'F' grades will be considered as backlog courses. 'F' grades will not be counted for GPA calculation but will stay permanently on the Grade Sheet and Transcript.

A student obtaining D grade in a course will be allowed to repeat the course for the purpose of grade improvement if CGPA of the student falls below **2.20**. In such case he/she will be awarded the new grade thus he/she obtains or retains his/her previous grade if he/she fails.

17. Performance Evaluation:

i) The minimum CGPA requirement for obtaining a B.Sc. Engineering/ Bachelor degree is **2.20**. The performance of a student will be evaluated in terms of two indices, viz. Semester grade point average and cumulative grade point average.

ii) Students will be allowed to sit in Backlog examination for maximum 3 courses (in same year) in an academic year. However only 4th year students are allowed to choose 3 courses from his/her Backlog course(s).

iii) Students must complete minimum 33 credits (Odd, Even semesters and Backlog examination) in each academic year for promotion to the next academic year.

18. Honors, VC's List and University gold medal:

18.1 **Honors:** Candidates for Bachelor's degree will be awarded the degree with honors if their CGPA is 3.75 or above and will be called as First Class with Honors.

18.2 **Class:** Candidates having CGPA 3.00 or above and less than 3.75 will be called as First Class and Candidates having CGPA **2.20** or above and less than 3.00 will be called as Second Class.

18.3 **VC's List:** In recognition of excellent performance, the names of students who maintain good standing with the University obtaining SGPA of 3.75 or above in two regular semesters in each academic year may be published in the VC's List in each

department. Students who have received F grade in any course during any of the two regular semesters will not be considered for VC's List in that year.

18.4 **University Gold Medal:** If a student can show extraordinary brilliance and obtains all A or better grades in all the courses he/she attended and fulfills the credit requirement for graduation will be honored by awarding University gold medal in a special function/convocation.

19. Student Classification:

The regular students are classified according to the number of credit hours earned towards a degree shown in the following table:

Year	Earned Credits
First Year	0 to 33
Second Year	34 to 66
Third Year	67 to 99
Fourth Year	100 and above/ For Architecture 100 to 132
Fifth Year (Architecture)	133 and above (Arch)

A student must earn minimum 33 credits in each academic year for promotion into the next year class.

20. Registration for the Second & Subsequent Semesters:

A student is normally required to register courses according to the approved curricula in each semester. After odd semester final examination, Students will normally register courses in even semester.

After Even semester final examination, students provisionally register courses for the odd semester in next academic year. If he/she fails to complete 33 credits in odd, even and backlog examinations for that academic year, his/her registration will be cancelled and he/she will not be promoted to next academic year. He/she then register courses in the previous academic year.

21. Measures for Helping Academically weak Students:

The following provisions are made in order to help academically weak students to enable them to complete their studies within the maximum period of seven years. Adviser will keep special contact for all such students

i) Whose Cumulative grade point average (CGPA) is less than 2.20 at the end of a semester.

ii) Fails to complete 33 credits in an academic year.

22. Backlog Examination:

i) There will be Backlog Examination after the publication of result of Even semester examination.

ii) 'F' grade(s) obtained after semester examination will be considered as backlog course(s).

iii) Students are allowed to sit for maximum 3 backlog courses in odd and/or even semester(s).

iv) Class test marks of Backlog courses in odd/ even semester(s) will be counted for Backlog examination.

v) Maximum B (B regular) grade will be counted in Backlog examination.

Backlog Courses: The course(s) which a student registered in a Semester but after Semester examination he/she obtained 'F' grade in that course(s).

23. Short Semester Examination:

The Short Semester Examination on only backlog courses may be conducted for the students who have participated in their 4(four)/5(Five) year degree course (up to 4th /5th year backlog examination) and have a shortage of maximum 5 (Five) incomplete courses including sessional, project and thesis to obtain Bachelor degree. The short semester examination will be arranged in a convenient time by the Head of the Department within 10 weeks of the publication of results of the final year backlog examination. The evaluation system will be the similar as regular semester. The students willing to appear at the short semester examination have to apply to the Head of the Department and with his permission must register within 7(seven) working days of publication of final year Backlog examination results. A student who has failed in the short semester examination will need to register backlog course(s) in the regular semester. Student(s) will be allowed to register for short semester only one time in his academic life. Maximum grade B+ (B plus) will be counted in short semester examination.

24. Minimum Earned Credit and GPA Requirements for Obtaining Degree:

Minimum credit requirements for the award of Bachelor Degree will be recommended by the respective Academic Committee to the Academic Council. The minimum CGPA requirements for obtaining a Bachelor Degree are 2.20.

25. Time Limits for Completion of Bachelor's Degree:

A student must complete his/her studies within a maximum period of seven years for 4 year bachelor degree and eight years for 5 year bachelor degree.

26. Industrial/Professional Training Requirements:

Depending on each Department's own requirement a student may have to complete a prescribed number of days for industrial/professional training as mentioned in the course curricula.

27. Application for Graduation and Award of Degree:

A student who has fulfilled all the academic requirements for bachelor's degree will have to apply to the Registrar/VC through his/her Adviser for graduation. Provisional degree will be awarded on completion of Credit and GPA requirements. Such provisional degrees will be confirmed by the academic council.

28. Inclusion of repeaters from the present system to the new course system:

Repeater students will be included in the course system of curricula as and when such situation will arise. Equivalence of Courses and Grades (if required) will be done by Academic Council with recommendation by the respective Academic and Dean Committee.

29. Absence during Semester:

A student should not be absent from quizzes, tests etc. during the semester. Such absence will naturally lead to reduction in points/marks, which count towards the final grade. Absence in semester final examination will result in 'X' grade and that course will be completed in regular/ short semester examination.

A student who has been absent for short period, up to a maximum of three weeks due to illness, should approach the course teacher(s) or the course coordinator(s) for a make-up quizzes or assignments immediately on returning to the classes. Such request should be supported by medical certificate from University medical officer. The medical certificate issued by a registered medical practitioner (with the registration number shown explicitly or the certificates) will also be acceptable only in those cases where the student has valid reason for his/her absence from the University.

Conduct of Examination:

1. Dean of the respective Faculty will announce the date of final examinations with recommendation from the respective heads of the departments at least 1(one) week before the end of the semester classes.
2. Board viva will be held at 13th cycle as convenient by the department.
3. There will be an Examination Committee for each examination in every department as:

Sl No.	Name	Remarks
1.	Head	Chairman
2.	3 (Three) Teachers within the University not below the rank of Assistant Professor	Members
3.	1(One) Teacher from outside the University (Not below the rank of Associate Professor)	External Member

For 4th year backlog and short semester examination committee no. of internal members will be 4.

4. Odd, Even, Backlog and Short Semesters will be treated as separate examinations.
5. Head of the department will put forward the proposal of formation of the examination committee to respective Dean of the Faculty. Dean will place this proposal to the Dean's executive committee for recommendation to the Academic Council's approval.
6. Chairman of the Examination committee will propose the name of the Paper Setters and Examiners from the panel of Paper setters and Examiners to the Vice-chancellor. Vice-Chancellor will appoint the examiners. Two Paper Setters and Examiners will be appointed for each course.
7. Examination Committee will moderate the questions for semester final, backlog and short semester examinations.
8. Chairman of the Examination committee will arrange to prepare question typing and printing (as required). The persons involved for preparation of question papers will be kept among the members of the respective examination committee.
9. Printed Questions will be sent to Dean in sealed envelope signed by the Chairman of the Examination committee and the person involved with question preparation at least 1(one) day before the examination.
10. Dean will keep the questions and will open and distribute the questions to the invigilators before the examination(s).
11. Results of Even semesters must be published before the start of next academic year.
12. Backlog examination must be completed within 2nd cycle of the odd semester.
13. After examinations all answer scripts will be submitted to Dean's office by the invigilators.
14. Examiners, who will perform invigilation duty, must collect the answer script from the Dean's office after the examinations on same day. All other examiners will collect the answer script from Dean's office on next office day.

Script Evaluation:

1. There will be two sections in the questions and answer script. Each examiner will evaluate one section.
2. Examiners will send four copies of mark sheet along with marked answer script to the Chairman of Examination committee.

3. Chairman of the examination committee will send the answer script with mark sheet and questions to the scrutinizers for scrutiny.
4. Vice-Chancellor will appoint two Scrutinizers on recommendation from the Chairman of the examination committee.
5. Vice-Chancellor will appoint three tabulators/Data Entry Teachers on recommendation from the chairman of the examination committee. Advisor(s) or other teacher (as required) may be the Tabulators/ Data entry teachers for a particular series and will continue to do so until that series will pass away. However the appointment will be on annual basis.
6. Chairman of the examination committee will provide the three copies of scrutinized mark sheets to the tabulators/Data Entry Teachers.
7. Chairman of the examination committee will arrange examination committee meeting for result finalization.
8. Tabulation will be done at a secured place under the supervision of the chairman of the examination committee.
9. Proper security measure is required to be taken.
10. Chairman of examination committee will send the three copies of prepared result along with one copy of scrutinized mark sheet to the Controller of Examination.
11. Controller of examination will publish the result after the approval of the Vice-Chancellor.
12. Grade sheets will be prepared and checked by the tabulators.

Special Instructions:

1. Students will not be allowed to enter the examination hall after half an hour from the start of the final examination(s).
2. Students will not be allowed to leave the exam hall before completion of one hour from the start of examination.
3. Students are not allowed to keep any electronic device unless it is officially permitted.
4. Students normally will not be allowed to go outside the exam hall during examination.
5. Students will be under Ordinance related to discipline for any unfair means as laid out.

Effectiveness: This ordinance, Instruction and procedure will be effective for student entry session 2013-2014 and so on. In case of any discrepancy Academic council will take necessary actions.

SYLLABUS

Distribution of Undergraduate Courses

Course type	% of Credit	Credits
Mathematics and Basic Sciences	12.66	**20.25**
(a) Mathematics	7.50	12
(b) Physics	2.81	4.50
(c) Chemistry	2.34	3.75
Humanities	6.56	**10.50**
(a) Economics, Government & Sociology	1.88	3.00
(b) Industrial Management & Accountancy	1.88	3.00
(c) English with Sessional	2.81	4.50
Basic and Major Engineering	80.78	**129.25**
(i) Electrical Engineering with Sessional	7.50	12.00
(ii) Core Engineering	73.28	117.25
(a) Theoretical	52.50	84
(b) Sessional, Project and Thesis	20.78	33.25
Total	**100.00**	**160.00**

Summary of Undergraduate Course Plan

Sl. No.	Year/Semester	Theory		Sessional		Total Credits
		No of Course	Credits	No of Course	Credits	
1	1st/Odd	5	15.00	5	6.00	21.00
2	1st/Even	5	15.00	4	5.25	20.25
3	2nd/ Odd	5	15.00	4	5.25	20.25
4	2nd/ Even	5	15.00	4	4.50	19.50
5	3rd/ Odd	5	15.00	5	5.25	20.25
6	3rd/ Even	5	15.00	5	4.50	19.50
7	4th/ Odd	5	15.00	5	4.00	19.00
8	4th/ Even	5	15.00	4	5.25	20.25
	Total=	40	120.00	36	40.00	160.00

Courses offered to the Undergraduate students of
Computer Science & Engineering Department

1st YEAR ODD SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 1100	Computer Fundamentals and Ethics	0	3	1.50
2	CSE 1101	Computer Programming	3	0	3.00
3	CSE 1102	Sessional Based on CSE 1101	0	3	1.50
4	EEE 1151	Basic Electrical Engineering	3	0	3.00
5	EEE 1152	Sessional Based on EEE 1151	0	3/2	0.75
6	Math 1113	Differential and Integral Calculus	3	0	3.00
7	Hum 1113	Functional English	3	0	3.00
8	Hum 1114	English Language Lab	0	3	1.50
9	Chem1113	Inorganic and Physical Chemistry	3	0	3.00
10	Chem1114	Sessional Based on Chem 1113	0	3/2	0.75
		Total=	15	12.00	21.00

1st YEAR EVEN SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 1200	Analytical Programming	0	3/2	0.75
2	CSE 1201	Data Structure	3	0	3.00
3	CSE 1202	Sessional Based on CSE 1201	0	3	1.50
4	CSE 1203	Object Oriented Programming	3	0	3.00
5	CSE 1204	Sessional Based on CSE 1203	0	3	1.50
6	Math1213	Co-ordinate Geometry and Ordinary Differential Equation	3	0	3.00
7	Hum1213	Economics, Government and Sociology	3	0	3.00
8	Phy 1213	Physics	3	0	3.00
9	Phy 1214	Sessional Based on Phy 1213	0	3	1.50
		Total=	15	10.50	20.25

2nd YEAR ODD SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 2100	Software Development Project I	0	3/2	0.75
2	CSE 2101	Discrete Mathematics	3	0	3.00
3	CSE 2102	Sessional Based on CSE 2101	0	3	1.50
4	CSE 2103	Numerical Methods	3	0	3.00
5	CSE 2104	Sessional Based on CSE 2103	0	3	1.50
6	EEE 2151	Analog Electronics	3	0	3.00
7	EEE 2152	Sessional Based on EEE 2151	0	3	1.50
8	Math 2113	Vector Analysis and Linear Algebra	3	0	3.00
9	Hum 2113	Industrial Management and Accountancy	3	0	3.00
		Total=	15	10.50	20.25

2nd YEAR EVEN SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 2201	Computer Algorithms	3	0	3.00
2	CSE 2202	Sessional Based on CSE 2201	0	3	1.50
3	CSE 2203	Digital Techniques	3	0	3.00
4	CSE 2204	Sessional Based on CSE 2203	0	3	1.50
5	CSE 2205	Finite Automata Theory	3	0	3.00
6	CSE 2206	Sessional Based on CSE 2205	0	3/2	0.75
7	EEE 2251	Electrical Machines and Instrumentations	3	0	3.00
8	EEE 2252	Sessional Based on EEE 2251	0	3/2	0.75
9	Math 2213	Complex Variable, Differential Equations and Harmonic Analysis	3	0	3.00
		Total=	15	9.00	19.50

3rd YEAR ODD SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 3100	Web Based Application Lab/Project	0	3/2	0.75
2	CSE 3101	Database Systems	3	0	3.00
3	CSE 3102	Sessional Based on CSE 3101	0	3	1.50
4	CSE 3103	Data Communication	3	0	3.00
5	CSE 3104	Sessional Based on CSE 3103	0	3/2	0.75
6	CSE 3105	Software Engineering	3	0	3.00
7	CSE 3107	Applied Statistics and Queuing Theory	3	0	3.00
8	CSE 3109	Microprocessors and Assembly Language	3	0	3.00
9	CSE 3110	Sessional Based on CSE 3109	0	3	1.50
10	CSE 3112	Technical Writing and Presentation	0	3/2	0.75
		Total=	15	10.50	20.25

3rd YEAR EVEN SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 3200	Software Development Project II	0	3/2	0.75
2	CSE 3201	Operating Systems	3	0	3.00
3	CSE 3202	Sessional Based on CSE 3201	0	3/2	0.75
4	CSE 3203	Computer Architecture and Design	3	0	3.00
5	CSE 3205	Computer Networks	3	0	3.00
6	CSE 3206	Sessional Based on CSE 3205	0	3	1.50
7	CSE 3207	Peripherals and Interfacings	3	0	3.00
8	CSE 3208	Sessional Based on CSE 3207	0	3/2	0.75
9	CSE 3209	Artificial Intelligence	3	0	3.00
10	CSE 3210	Sessional Based on CSE 3209	0	3/2	0.75
		Total=	15	9.00	19.50

4th YEAR ODD SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 4000	Project/Thesis I	0	2	1.00
2	CSE 4101	Compiler Design	3	0	3.00
3	CSE 4102	Sessional Based on CSE 4101	0	3/2	0.75
4	CSE 4103	Digital Signal Processing	3	0	3.00
5	CSE 4104	Sessional Based on CSE 4103	0	3/2	0.75
6	CSE 4105	Digital Image Processing	3	0	3.00
7	CSE 4106	Sessional Based on CSE 4105	0	3/2	0.75
8	CSE ****	Optional I	3	0	3.00
9	CSE ****	Sessional Based on Optional I	0	3/2	0.75
10	CSE ****	Optional II	3	0	3.00
		Total=	15	9.00	19.00

List of Optional Courses

	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
Optional I	CSE 4107	Information System Analysis and Design	3	0	3.00
	CSE 4108	Sessional Based on CSE 4107	0	3/2	0.75
	CSE 4109	Unix Programming	3	0	3.00
	CSE 4110	Sessional Based on CSE 4109	0	3/2	0.75
	CSE 4111	Digital System Design	3	0	3.00
	CSE 4112	Sessional Based on CSE 4111	0	3/2	0.75
	CSE 4113	Simulation and Modeling	3	0	3.00
	CSE 4114	Sessional Based on CSE 4113	0	3/2	0.75
	CSE 4115	Wireless Networks	3	0	3.00
	CSE 4116	Sessional Based on CSE 4115	0	3/2	0.75
Optional II	CSE 4117	Parallel and Distributed Processing	3	0	3.00
	CSE 4119	Human Computer Interaction	3	0	3.00

	CSE 4121	Switching Systems	3	0	3.00
	CSE 4123	Control System Engineering	3	0	3.00

4th YEAR EVEN SEMESTER

Sl. No.	Course No.	Course Title	Theory Hrs./Week	Sessional Hrs/Week	Credit
1	CSE 4000	Project/Thesis II	0	6	3.00
2	CSE 4201	Computer Graphics and Animations	3	0	3.00
3	CSE 4202	Sessional Based on CSE 4201	0	3/2	0.75
4	CSE 4203	Neural Networks and Fuzzy Systems	3	0	3.00
5	CSE 4204	Sessional Based on CSE 4203	0	3/2	0.75
6	CSE 4206	Seminar	0	3/2	0.75
7	CSE ****	Optional I	3	0	3.00
8	CSE ****	Optional II	3	0	3.00
9	CSE ****	Optional III	3	0	3.00
		Total=	15	10.50	20.25

List of Optional Courses					
	Course No.	**Course Title**	**Theory Hrs./Week**	**Sessional Hrs/Week**	**Credit**
Optional I/II/III	CSE 4207	VLSI Design	3	0	3.00
	CSE 4209	Impact of Computer on Society	3	0	3.00
	CSE 4211	Network Planning	3	0	3.00
	CSE 4213	Knowledge Engineering	3	0	3.00
	CSE 4215	Network Security	3	0	3.00
	CSE 4217	Decision Support System	3	0	3.00
	CSE 4219	Computer Vision	3	0	3.00
	CSE 4221	Data Mining	3	0	3.00

Prerequisite courses are indicated in the detail syllabus.

DETAIL SYLLABUS

1st YEAR ODD SEMESTER

CSE 1100 **Contact hours/week: 3**

Computer Fundamentals and Ethics **Credits: 1.50**

Prerequisite: None

Computer Fundamentals: Introduction to Computer Basics, Types and Generation of Computers; Basic Organization and Functional Units.

Hardware: Basic Units of Computer Hardware; Processors; Input, Output and Memory Devices; Keyboard; Mouse; OMR; OCR; MICR; CD-ROM; Printers; CRT; LCD; LED; Microfilm; Floppy.

Software: Types of Software; System Software: Familiarization with Various Operating Systems (Windows, DOS, UNIX, Android, IOS Etc.); Application Software: Text Processing (MS-WORD, etc); Spread Sheet (MS-EXCEL etc).

Language: Machine Language; Assembly Language; High Level Language; Assembler; Translator; Interpreter and Compiler.

Database Management: Introduction of Data, Information and Management; Studying Various Tools like Foxpro, MS Access, Oracle etc; Mathematical and Simulation (Math Cad, Matlab etc.); Data Communications and Internet.

Computer Ethics: Computers in the Workplace; Computer Crime; Rules of Communications; Privacy; Intellectual Property; Impact on Employment; Professional Responsibility; Globalization.

CSE 1101 **Contact hours/week: 3**

Computer Programming **Credits: 3.00**

Prerequisite: None

Introduction to Computer Programming: Algorithm, Writing, Debugging and Running Programs using C/C++ Compiler.

C/C++ Basics: Different Data Types and their Range, Operator and Operands and its Precedence, Input/Output, Conditional Operators, Loops Nested Structure, Error Handling, Built-in Functions.

Functions and Arrays: Writing & Calling of User–defined Functions, Recursive Functions, Scope of Variables, Introduction to One-Dimensional Arrays, Multi-Dimensional Arrays and Array Manipulation.
Pointers and Strings: Introduction to Pointers, Pointers and Array, Pointers and Functions, String I/O, String-based Built-in Functions, String Operations, Pointer and String.

Files: Introduction to Files in C/C++, Opening, Closing and Updating Binary and Sequential Files.

Advanced Topics: Operations on Bits, Register Variable, Pre-Processors and Graphics in C/C++.

CSE 1102 **Contact hours/week: 3**
Sessional based on CSE 1101 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory course CSE 1101.

EEE 1151 **Contact hours/week: 3**
Basic Electrical Engineering **Credits: 3.00**
Prerequisite: None

Basics of Electrical Circuit: Electrical Units and Standards. Electrical Circuit Elements and Models. Signal and Waveforms. Fourier Representation of Non-Sinusoidal Waveforms. RMS and Average Value of Sinusoidal Waveforms. Introduction to Phasor Algebra. DC & Steady State AC Circuit Solutions: Series, Parallel, Series-Parallel Networks, Loop and Nodal Methods, Delta-Wye Transformations.

Circuit Theorems: KVL, KCL, Thevenin, Norton, Super-position, Reciprocity and Maximum Power Transfer Theorems, Resonance. Circuit Analysis using Popular Simulation Tools.

EEE 1152 **Contact hours/week: 3/2**
Sessional based on EEE 1151 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory course EEE 1151.

Math 1113 **Contact hours/week: 3**
Differential and Integral Calculus **Credits: 3.00**
Prerequisite: None

Differential Calculus: Limit, Continuity and Differentiability. Differentiation of Explicit and Implicit Function and Parametric Equations. Significance of Derivatives, Differentials, Successive Differentiation of Various Types of Functions. Leibnitz's Theorem. Rolle's Theorem, Mean Value Theorems. Taylor's Theorem in Finite and Infinite Forms. Maclaurin's Theorem in Finite and Infinite Forms. Langrange's Form of Remainders. Cauehy's Form of Remainder. Expansion of Functions by Differentiation and Integration. Partial Differentiation. Euler's Theorem. Tangent and Normal, Maxima and Minima, Points of Inflection and Their Applications. Evaluation of Indeterminate Forms by L'Hospitals Rule, Curvature, Evaluate and Inviolate. Asymptotes. Envelopes, Curve Tracing.

Integral Calculus: Definitions of Integration, Integration by The Method of Substitutions, Integration by The Method of Successive Reduction. Definite Integrals. Beta Function and Gamma Function. Area Under a Plane Curve in Cartesian and Polar Co-Ordinates. Area of the Region Enclosed by Two Curves in Cartesian and Polar Co-Ordinates, Parametric and Pedal Equations. Intrinsic Equation. Volumes of Solids of Revolution. Volume of Hollow Solids of Revolution by Shell Method. Area of Surface of Revolution.

Hum 1113 **Contact hours/week: 3**
Functional English **Credits: 3.00**
Prerequisite: None

Grammar: Construction and Transformation of Sentences, Analysis of Sentence, Structure, Use of Preposition, Question Words, WH & Yes/No Question, Phrases & Idioms, Correction, Conditional Sentences, Punctuation, Pronunciation, Phonetic Transcription, Spoken English.

Composition: Definition of Scientific Terms, Comprehension, Précis Writing, Commercial Correspondence, Paragraph Writing, Amplification, Tenders & Schedules, Memos & Press-Release, Report Writing.

Short Stories:

The Diamond Necklace – Guy De Mapausant
Meeting in the Mosque – E. M. Forster
Tickets, Please – D. H. Lawrence
The Dead – James Joyce

Hum 1114 **Contact hours/week: 3**
English Language Lab **Credits: 1.50**
Prerequisite: None

Developing Reading Skill: Strategies of Reading Skimming, Scanning, Predicting, Inferencing; Practicing Comprehension from Literary and Non Literary Texts.

Developing Writing Skill: Sentence Variety; Generating Sentences, Clarity and Correctness of Sentences, Linking Sentences for Paragraphs, Writing Paragraphs, Essays, Reports Formal and Informal Letters.

Developing Listening Skill: Listening to Recorded Texts and Class Lectures and Learning to Take Notes.

Developing Speaking Skill: Oral Skills Including Communicative Expressions for Personal Identification, Life at Home, Giving Advice and Opinion, Instruction and Directions, Requests, Complains Apologies, Describing People and Places, Narrating Events.

Chem 1113 **Contact hours/week: 3**
Inorganic and Physical Chemistry **Credits: 3.00**
Prerequisite: None

Chemical Bond: Different Types of Chemical Bonds; Properties of Ionic and Covalent Compounds, Modern Approach of Covalent Bond.

Thermo-chemistry: Types of Energy, Enthalpy of Reaction, Heat of Combustion, Heat of Formation and Heat of Neutralization, Experimental Determination of Thermal Changes During Chemical Reaction.

Titration: Acid Base Titration and its Problem During the Process of Titration.

Solution: Types of Solution, Factors Influencing the Solubility of Substance. Mechanism of Dissolution; Solution of Gases in Liquids, Different Units of Concentration, Distribution Law and its Application; Properties of Dilute Solution, Raoult's Law - its Application, Elevation of Boiling Point, Depression of Freezing Point and Osmotic Pressure.

Electro-chemistry: Electrolytes, Mechanism of Electrolytic Conduction, Transport Number and Electrolytic Conductance.

Kinetics and Chemical Equilibrium: Rate of a Reaction, Factors Determining the Rate, Law of Mass Action, Evaluation and Characteristics of Equilibrium Constant of Reaction; the Lechatclier's Principle.

Colloid: Colloids and Properties of Colloidal System and its Application.

Chem 1114 **Contact hours/week: 3/2**
Sessional based on Chem 1114 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory course Chemistry 1114.

1st YEAR EVEN SEMESTER

CSE 1200 **Contact hours/week: 3/2**
Analytical Programming **Credits: 0.75**
Prerequisite: CSE 1101

Student will Solve at least 30 (Thirty) Problems using C, C++ or Java. Among them at Least three Problems should be Submitted from Geometry, Mathematics, String Processing, Tree, Graph and Sorting Techniques.

CSE 1201 **Contact hours/week: 3**
Data Structure **Credits: 3.00**
Prerequisite: CSE 1101

Introduction: Concepts and Examples of Elementary Data Objects, Necessity of Structured Data, Types of Data Structure, Ideas on Linear and Nonlinear Data Structure.

Linear Array: Linear Array & its Representation in Memory, Traversing LA, Insertion & Deletion in LA, Bubble Sort, Linear Search & Binary Search, Multidimensional Array & its Representation in Memory, Algebra of Matrices, Sparse Matrices.

Stack: Stack Representation & Applications; PUSH and POP Operation on Stack. Polish Notation, Reverse Polish Notation; Evaluation of a Postfix Expression; Transforming Infix Expression into Postfix Expression.

Queue: Its Representation, Insertion & Deletion in Queue, Priority Queues, Recursion [Factorial Function, Fibonacci Sequence, Ackermann Function, Towers of Hanoi].

Linked List: Linked List & its Representation in Memory, Traversing, Searching, Insertion & Deletion Operation on Linked List, Circular List, Header Linked Lists, Two Way Lists.

Complexity: Algorithm and Flow Chart, Complexity of Algorithms, Rate of Growth, Big O Notation, Complexity of Linear Search, Binary Search & Bubble Sort Algorithm.

Sorting: Insertion Sort, Selection Sort, Quick Sort, Merge Sort, Searching & Data Modification, Hash Function, Collision Resolution, Chaining.

Tree: Tree Terminology, Representation of Binary Trees in Memory, Traversing Binary Tree, Binary Search Tree, Insertion & Deletion on Binary Search Tree, Insertion & Deletion on Heap, Heap Sort, B Trees, General Tree.

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CSE 1202 **Contact hours/week: 3**
Sessional based on CSE 1201 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory course CSE 1201

CSE 1203 **Contact hours/week: 3**
Object Oriented Programming **Credits: 3.00**
Prerequisite: CSE 1101

Fundamentals of OOP: Introduction to Object Oriented Programming, Principles of Object Oriented Design, Encapsulation and Information-hiding, Inheritance, Polymorphism, Data Binding, Static and Dynamic Binding.

Classes and Objects: Structure of Class, Access Modifiers, Nested Classes, Abstract Classes, Arrays of Objects, Pointer to Objects, Friend function, Data abstraction.

Constructors and Destructors: Default Constructor, Copy Constructor, Dynamic Constructor, Constructor Function for Derived Class and their Order of Execution, Destructor.

Inheritance: Single Inheritance vs. Multiple Inheritance, Mode of Inheritance, Virtual Inheritance.

Polymorphism: Operator and Function Overloading, Run-Time and Compile Time Polymorphism, Virtual Function, Errors and Exception Handling.

Advanced Topics: Persistent Objects, Objects and Portable Data, UML Basics, Design Patterns, Multithreading.

Reference Programming Language(s): C++ and Java.

CSE 1204 **Contact hours/week: 3**

Sessional based on CSE 1203 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory course CSE 1203

Math 1213 **Contact hours/week: 3**
Co-ordinate Geometry and Ordinary Differential Equation **Credits: 3.00**
Prerequisite: None

Co-ordinate Geometry: Co-ordinate Geometry of Two Dimensions: Change of Axes, Transformation of Co-Ordinates, Simplification of Equations of Curves.

Co-ordinate Geometry of Three Dimensions: System of Co-Ordinates, Distance between two Points, Section Formula, Direction Cosines and Projection, Planes and Straight Lines.

Ordinary Differential Equation: Degree and Order of Ordinary Differential Equations. Formation of Differential Equations. Solutions of First Order Differential Equations by Various Methods, Solutions of General Linear Differential Equations of Second and Higher Orders with Constant Coefficients, Solution of Homogeneous Linear Differential Equations. Solution of Higher Order Differential Equations when the Dependent of Independent Variables are Absent. Solution of Differential Equation with Constant Coefficients by Operator Method. Differential Equations with Variable Coefficients.

Hum 1213 **Contact hours/week: 3**
Economics, Government and Sociology **Credits: 3.00**
Prerequisite: None

Economics: Nature of the Economics Theory Applicability of Economic Theory to the Problems of Developing Countries, Some Basic Concepts Supply, Demand and their Elasticity. Economics and Technology. Producer's Equilibrium-Isoquant. Production - Factors of Production, Production Possibility Curve-Equilibrium of a Firm, Fixed Cost and Variable Cost, Laws of Returns ,Internal and External Economics and Dis-Economics, Input Output Analysis. Economic Growth and Economic Development and Planning Basic Concept-Saving, Investment, GNP, NNP, Per-Capita Income, Growth Rate, Fiscal Policy, Monetary Policy and Trade Policy and their Relative Applicability in Bangladesh, Planning-Five Year Plans of Bangladesh, Development Problems Related to Agriculture. Industry and Population of Bangladesh.

Government: Basic Concepts of Government and Politics. Functions, Organs and Forms of Modern State and Government, Socialism. Capitalism, UNO, Government and Politics of Bangladesh, Some Major Administrative Systems of Developed Counties. Local Self - Government. Central Government, Public Opinion.

Sociology: Scope, Culture and Civilization Relationship, Social Structure of Bangladesh. Industrial Revolution, Urbanization and Industrialization, Urban Ecology, Cyber Crime and Delinquency, Sociology of Education. Relationship-Sociology and Cyber Crime. Causes and Remedies of Cyber Crime.

Phy 1213 **Contact hours/week: 3**
Physics **Credits: 3.00**
Prerequisite: None

Structure of Matter: Structure of Matter. Different Types of Bonds in Solids: Metallic, Van Dar Waals', Covalent and Ionic Bond, Packing in Solids: Inter Atomic Distances and Forces of Equilibrium, X-Ray Diffraction, Bragg's Law. Distinction Insulator, Semiconductor and Conductor.

Atomic Physics: Atom Models: Thomson Atom Model, Rutherford Atom Model, Rutherford Scattering Formula, Electron Orbits, Bohr Atom Model, Energy Levels and Spectra, Particle Properties of Waves: Photoelectric Effect, Einstein's Photoelectric Equation, Laws of Photoelectric Emission, Photovoltaic Cells, Compton Effect. Wave Properties of Particle: De Broglie Waves, Group Velocity, Phase Velocity.

Waves and Oscillations: Oscillations: Simple Harmonic Motion, Composition of Simple Harmonic Motions and Lissajous' Figures, Damped and Forced Oscillations. Resonance. Waves: Travelling and Standing Waves, Energy Calculation of Traveling and Standing Waves, Intensity of Waves. Beats, Doppler Effect.

Theories of Light: Wave Theory: Huygens Wave Theory. Huygen's Principle and Construction, Superposition of Light Waves. Electromagnetic Theory. Particle Theory: Newton's Corpuscular Theory, Quantum Theory of Light.

Interference: Introduction, Conditions of Interference, Young's Double Slit Experiment, Fresnel's Biprism. Thin Film Interference, Interference Due to Multiple Reflection, Newtons Ring.

Diffraction: Fresnel's and Fraunhoper Diffraction, Diffraction by Single and Double Slit, Diffraction Gratings.

Polarization: Introduction, Methods of Producing Polarized Light, Polarization by Reflection and Refraction, Polarization by Double Refraction, Constrauvtion of Nicol Prism, Production and Analysis of Polarized Light, Optical Activity, Optics of Crystals, Polarimeters.

Phy 1214 **Contact hours/week: 3**
Sessional based on Phy 1213 **Credits: 1.50**
Prerequisite: None
Sessional based on the theory of course Phy 1213.

2nd YEAR ODD SEMESTER

CSE 2100 **Contact hours/week: 3/2**
Software Development Project-I **Credits: 0.75**
Prerequisite: None

Students will Develop one or more Programs / Projects on some Practical Problems with Sound Software Engineering Practices as Assigned by Teacher.

CSE 2101 **Contact hours/week: 3**
Discrete Mathematics **Credits: 3.00**
Prerequisite: None

Set: Operations on Sets, Algebraic Properties of Set, Computer Representation of Set, Cantor's Diagonal Argument and the Power Set Theorem, Schroeder-Bernstein Theorem.

Relation: Property of Relation, Binary Relations, Partial Ordering Relations, Equivalence Relations.

Function: Type of Functions, Growth of Function.

Propositional Logic: Syntax, Semantics, Valid, Satisfiable and Unsatisfiable Formulas, Encoding and Examining the Validity of Some Logical Arguments, Predicate and Quantifier, Universal and Existential Quantification; Modus Ponens and Modus Tollens.

Proof Techniques: The Structure of Formal Proofs, Direct Proofs, Proof by Counter, Proof by Contraposition, Proof by Contradiction, Mathematical Induction, Proof of Necessity and Sufficiency.

Number Theory: Theorem of Arithmetic, Modular Arithmetic, GCD, LCM, Prime Number, Congruence, Application of Congruence, Application of Number Theory, Chinese Remainder Theory.

Introduction to Counting: Basic Counting Techniques - Inclusion and Exclusion, Pigeon-Hole Principle, Permutation, Combination, Sequence and Summations, Introduction to Recurrence Relation and Generating Function.

Introduction to Graphs: Graphs and their Basic Properties - Degree, Path, Cycle, Sub-Graphs, Isomorphism, Euclidian and Hamiltonian Walks, Graph Coloring, Planar Graphs.

CSE 2102 **Contact hours/week: 3**
Sessional based on CSE 2101 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory of course CSE 2101.

CSE 2103 **Contact hours/week: 3**
Numerical Methods **Credits: 3.00**
Prerequisite: None

Modeling, Computers and Error Analysis: Mathematical Modeling and Engineering Problem Solving, Programming and Software, Approximations and Round-Off Errors, Truncation Errors and the Taylor Series.

Roots of Equations: Bracketing Methods, Open Methods, Roots of Polynomials,

Linear Algebraic Equations: Gauss Elimination, LU Decomposition and Matrix Inversion, Gauss-Seidel.

Optimization: One-dimensional Unconstrained optimization.

Curve Fitting: Least-square Regression

Interpolation: Interpolation with one and two Independent Variables, Formation of Different Difference Table, Newton's Forward and Backward Difference, Langrange's Interpolation.

Numerical Differentiation and Integration: Newton-Cotes Integration Formulas, Integration of Equations, Numerical Differentiation.

Ordinary Differential Equations: Runge-Kutta Methods, Boundary-Value and Eigenvalue Problems, Numerical Solution of Partial Differential Equations.

CSE 2104 **Contact hours/week: 3**
Sessional based on CSE 2103 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory of course CSE2103.

EEE 2151 **Contact hours/week: 3**
Analog Electronics **Credits: 3.00**
Prerequisite: None

Semiconductor Diodes: Semiconductor, n-and p-Type Semiconductors, p-n Junction as a Diodes and their V-I Characteristics, Zener Diode, Half-and Full Wave Rectifiers, Voltage Regulation using Zener Diodes.

Filters: Properties of Symmetrical Networks, Characteristics Impedance, Filter Fundamentals, Different Types of Filters, High Pass, Low Pass, Band Pass and Band Elimination Filter, Active Filters.

Linear Wave Shaping: Diode Wave Shaping Techniques, Clipping and Clamping Circuits, Comparator Circuits, Switching Circuits; Schmitt Trigger.

555 Timer: Architecture of 555 Timer, Different Application of 555 Timer, 555 as Monostable, Bistable and Astable Multivibrators.

Transistor: Transistor Action, Transistor Biasing, DC Characteristics of CE, CB and CC Configurations.
Transistor Amplifiers and Oscillators: CE, CB and CC Amplifiers, Current, Voltage and Power Gains, Frequency Responses, Principles of Feedback, Positive and Negative Feedback, and Oscillators.

EEE 2152 **Contact hours/week: 3**
Sessional based on EEE 2151 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory of course EEE 2111.

Math 2113 **Contact hours/week: 3**
Vector Analysis and Linear Algebra **Credits: 3.00**
Prerequisite: None

Vector Analysis: Vectors, Differentiation and Integration, Line, Surface and Volume Integrals, Gradient of a Function, Divergence and Curl of Vector and their Applications, Physical Significance of Gradient, Divergence and Curl, Vector Identities, Integral Forms of Gradient, Divergence and Curl, Green's Theorem, Stock's Theorem, Gauss's Divergence Theorem.

Matrix: Definition of Matrices, Equality of two Matrices, Addition, Subtraction and Multiplication of Matrices, Equivalence of Matrices, Positive and Negative Matrices, Adjoint of Matrices, Transpose and Inverse of Matrices, Rank and Normal form of Matrices, System of Linear Equations, Solution of Homogeneous and Non-Homogeneous Systems, Determination of Eigen Values and Eigen Vectors, Solutions of Matrix Differential Equations.

Linear Algebra: Vector Space, Subspace, Sum and Direct Sum, Hilbert Space, Normed Linear Space, Branch Space, Basis and Dimension. Linear Transformation: Range, Kernel, Nullity, Singular and Non-Singular Transformation. Linear Operations: Matrix Representation of a Linear Operator. Change of Basis, Similarity and Linear Mapping.

Hum 2113 **Contact hours/week: 3**
Industrial Management and Accountancy **Credits: 3.00**
Prerequisite: None

Industrial Management: Management: Principle of Management, Management Functions, Management Skills, Authority & Responsibility, Span of Control, Management by Objective, Consultative Management, Participative Management, Decision Making, Manpower Motivation. Human Resources Management: Manpower Planning, Recruitment & Selection, Employee Training & Development, Performance Appraisal, Wages & Salary Administration. Production Management: Plant Layout: Definition, Basic Layout Types, Problem Solving, Problem Solving, Linear Programming.EOQ, Lead Time, Safety Stock, Re-Order Point.

Accountancy: Basic Accounting Principles, Objectives of Accounting, Transaction, Double Entry Systems, Accounts and it's Classification, Journals Cash Book, Ledger, Trial Balance, Financial Statement. Cost Accounts & Objectives; Costs; Classification, Preparation of Cost Sheet, Cost Volume Profit (CVP) Analysis, Standard Costing, Process Costing.

2nd YEAR EVEN SEMESTER

CSE 2201 **Contact hours/week: 3**
Computer Algorithms **Credits: 3.00**
Prerequisite: CSE 1201, CSE 2101

Asymptotic Notations: Complexity Analysis of Algorithms, Worst Case, Best Case and Average Case.

Sorting Algorithms: Divide and Conquer Approach, Merge Sort and Quick Sort Algorithm, Complexity Analysis, Worst and Average Case Analysis, Heap Construction Algorithm, Heap Sort, Application of Heap: Priority Queue, Decision Tree Model and (Worst Case) Lower Bound on Sorting, Sorting in Linear Time - Radix Sort, Bucket Sort, Counting Sort, etc.

Graph Algorithms: Representation of Graphs, Breadth First Search, Depth First Search, Minimum Spanning Tree, Kruskal and Prims Algorithm.

Shortest Path: Dijkstra's Algorithm, Bellman-Ford Algorithm. Floyd Warshall Algorithm.

Searching Algorithms: Binary Search Trees, Balanced Binary Search Trees, AVL Trees and Red-Black Trees, B-Trees, Skip Lists, Hashing. Priority Queues, Heaps, Interval Trees.

Dynamic Programming: Longest Common Subsequence (LCS), Matrix Chain Multiplication (MCM), Knapsack Problem, Multistage Graphs.

Greedy Algorithm: Greedy Algorithm, Activity Selection Problem, Huffman Codes and its application, Knapsack problem, Tree Vertex Splitting.

Recurrences & Backtracking: Recurrences, *NP*-Hard and *NP*-Complete Problems, Backtracking, *n*-Queen Problem, Branch and Bounds.

Reducibility between Problems and NP-completeness: Lower Bound Theory, Discussion of Different NP-Complete Problems like Satisfiability, Clique, Vertex Cover, Independent Set, Hamiltonian Cycle, TSP, Knapsack, Set Cover, Bin Packing, etc. Computational Geometry, Line Segment Properties, Convex Hull, Graham Scan Algorithm of Convex Hull.

CSE 2202 **Contact hours/week: 3**
Sessional based on CSE 2201 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory of course CSE 2201.

CSE 2203 **Contact hours/week: 3**
Digital Techniques **Credits: 3.00**
Prerequisite: None

Information and Digital Systems: Introduction to Digital Systems, Number Systems, Weighted and Non-Weighted Codes, Error Detection Code, Binary Addition and Subtraction, 2's Compliment Methods.

Boolean Algebra and Combinational Logic Circuits: Digital Logic, Boolean Algebra, Boolean Function, Canonical Forms, Karnaugh Maps, Minimization of Boolean Functions, Logic Gates and their Truth Tables, Design Methodologies, Combinational Logic Circuit Design, Arithmetic and Data Handling Logic Circuits. Decoders, Encoders, Multiplexer, Demultiplexer.

Flip Flop and Sequential Logic Circuits: Transistor Latch, NAND Gate Latch, NOR Gate Latch, D Latch. Clock Signals and Clocked Ffs: Clocked SR, JK and D Flip-Flops, Master/Slave JK FF, Timing Diagram of Different Ffs, Edge-Triggered and Level-Triggered Timing Diagrams., Counters, Registers, Memory Devices and their Applications.

Technology Parameters: Fan In, Fan Out, Propagation Delay, Power Dissipation and Noise Immunity.

Others: Diode Logic Gates, Transistor Gates, MOS Gates, Logic Families: TTL and CMOS Logic with Operation Details.

CSE 2204 **Contact hours/week: 3**
Sessional based on CSE 2203 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory of course CSE 2203.

CSE 2205 **Contact hours/week: 3**
Finite Automata Theory **Credits: 3.00**
Prerequisite: None

Finite State Machine: Fundamental of Finite State Machine, State Equivalence and Minimization of Machine, Incompletely Specified Machine and Minimal Machine, Merger Graph and Compatibility Graph, Finite Memory and Definite Memory Machine, Information Lossless Machine and Inverse Machine.

Finite Automata: Introduction to Finite Automata, Structural Representations, Automata and Complexity, an Informal Picture of Finite Automata, Deterministic Finite Automata, Non-Deterministic Finite Automata**,** an Application (i.e. Text Search or other), Finite Automata with Epsilon-Transitions.

Regular Expressions and Languages: Regular Expressions, Finite Automata and Regular Expression, Application of Regular Expressions, Algebraic Laws for Regular Expressions; Closure Properties of Regular Language, Decision Properties of Regular Languages, Equivalence and Minimization of Automata.

Context-Free Grammar and Languages: Context-free Grammars, Parse Trees, Application of Context-Free Grammars, Ambiguity in Grammars and Languages, Normal Forma for Context-Free Grammars, The Pumping Lemma for Context-Free Languages, Closure Properties of Context-Free Languages, Decision Properties of CFL's.

Pushdown Automata: Definition of the Pushdown Automata, the Languages of a PDA, Equivalence of PDA's and CFG's, Deterministic Pushdown Automata.

Introduction to Turing Machines: The Turing Machine, Programming Techniques for Turing Machines, Extensions to the Basic Turing Machine, Restricted Turing Machines, Turing Machines and Computers.

Undecidability: A language that is not recursively enumerable, an undecidable problem that is RE, undecidable problems about turing machines, post's correspondence problem, other undecidable problems.

CSE 2206 **Contact hours/week: 3/2**
Sessional based on CSE 2205 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 2205.

EEE 2251 **Contact hours/week: 3**
Electrical Machines and Instrumentations **Credits: 3.00**
Prerequisite: EEE 1151

DC Machines: Operation and Performance Characteristics of Generators and Motors. Starting, Speed Control and Braking of Motors. Different Application of DC Motors.

AC Machines: Transformer: Principle of Operation of Transformer. Single Phase Induction Motors and its Methods Of Starting.

Synchronous Machines and Motors: Principles of Operation and Equivalent Circuit. Method of Synchronization. Special Motors: Stepper Motor, Servomotor, Brush Less Motors.

Measuring Instruments: Electromechanical and Electronic Meters and their Uses. Extension of Instrument Range.

Transducers: Different Types of Transducers and their Principle of Operations: Position and Displacement Transducers, Potentiometer, Linear Variable Differential Transformers (LVDT), Pressure Transducer, Temperature Transducer, Optical Transducer, Ultrasonic Transducer; Humidity Transducer, Hall Effect Transducer, and Speed Transducer.

EEE 2252 **Contact hours/week: 3/2**
Sessional based on EEE-2251 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course EEE 2221.

Math 2213 **Contact hours/week: 3**
Complex Variable, Differential Equations and Harmonic Analysis **Credits: 3.00**
Prerequisite: None

Complex Variable : Complex Number Systems, General Functions of a Complex Variable, Limits and Continuity of a Function of Complex Variable and Related Theorems, Complex Differentiation and the Cauchy-Riemenn Equations, Infinite Series, Convergence, Line Integral, Cauchy Integral Theorem, Cauchy Integral Formula, Liouville's Theorem, Taylor's and Laurent's Theorems, Singular Points, Residue, Cauchy's Residue Theorem, Contour Integration.

Differential Equations: Series Solution: Singular Points, Series Solutions: Frobenius Method, Bessel's and Legender's Differential Equations.

Partial Differential Equation: Partial Differential Equations, Solution of First Order Partial Differential Equation by Lagrange and Charpit Methods, Solution of Laplace Equation and Wave Equation.

Harmonic Analysis and Laplace Transform: Fourier Series and Fourier Transformations and its Applications to Solve Boundary Value Problems. Laplace Transforms, Inverse Laplace Transforms, Solution of Differential Equation by Laplace Transforms.

3rd YEAR ODD SEMESTER

CSE 3100 **Contact hours/week: 3/2**
Web Based Application Lab/Project **Credits: 0.75**
Prerequisite: None

Students will Work in Groups or Individually to Develop Web based Applications and Design a Web Site by Adding Client Side and Server Side Scripting and Interfacing the Web Applications to a Database.

CSE 3101 **Contact hours/week: 3**
Database Systems **Credits: 3.00**
Prerequisite: None

Concepts of Database Systems: Files and Databases, Database Management Systems; Transaction Management, Structure of a DBMS, Applications.

Entity-Relationship Concepts: Entity Types, Entity Set, Attribute and Key, Relationships, Relation Types, Entity Relationship, ER Modeling, ER Diagrams, Database Design using ER Diagrams, Enhanced Entity-Relationship (EER) Model.

Normalization: Normal Forms, Normalized Relations and Database Performance; De-Normalization.

Relational Model: Structure of Relational Databases, Relational Algebra, Relational Algebra Operations, Modification of the Database, Introduction to Views, Pitfalls in Relational Database Design.

SQL: Data Definition Language, Data Manipulation Language, Basics of SQL, Query Designing in SQL using Aggregate Functions and Nested Queries, Embedded SQL, Triggers, Procedures; Indexes; Declarative Constrains and Database Triggers.

Concurrency Control: Lock based Protocols, Timestamp based Protocols, Validation based Protocols, Deadlock.

Recovery System: Failure Classification, Storage Structure, Recovery and Atomicity, Log-based Recovery, Recovery with Concurrent Transactions, Advanced Recovery Techniques, RAID Model.

Advanced Database Management Systems: No SQL Systems, Distributed Systems, Object-Oriented System, Temporal, Database Security, Data Warehousing and Data Mining, Database Administration and Tuning.

CSE 3102 **Contact hours/week: 3**
Sessional based on CSE 3101 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory of course CSE 3101.

CSE 3103 **Contact hours/week: 3**
Data Communication **Credits: 3.00**
Prerequisite: None

Fundamental: Representation of Signals in Time and Frequency Domain, Properties of Fourier Transform, Delta Function, Auto-Correlation and Cross-Correlation.

Data Communication and Network Model: Data Communication, Fundamental of Networks, History of the Internet, Protocols and Standards.

Signal and System, Transmission Media, Interfaces: Analog and Digital Data, Periodic Analog Signals, Digital Signals, Transmission Impairment, Data Rate Limits and Performance.

Digital and Analog Transmission: Digital to Digital Conversion, Line Encoding Schemes, Block Coding, Scrambling, Analog to Digital Conversion, Transmission Modes, Digital to Analog Conversion, Bandwidth Utilization, Analog to Digital Conversion.

Multiplexing, Spreading and Switching: Multiplexing, Spread Spectrum, Packet-Switched Data Networks, Circuit Switched Data Networks, Virtual Circuit Networks.

Transmission Medium: Guided Media and Unguided Media.

CSE 3104 **Contact hours/week: 3/2**
Sessional based on CSE 3103 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 3103.

CSE 3105 **Contact Hours/week: 3**
Software Engineering **Credits:3.00**
Prerequisite: None

Introduction: Introduction to Software and its Nature, Software Engineering Methods, Professional and Ethical Responsibility of a Software Engineer.

Software Process Model: Different Types of Software Process Model and their Implementations, Costs of Software Engineering.

Software Requirement Analysis: Software Requirements Analysis and their Applications, Software Prototyping, Basic Concepts of Different Formal Software Specification.

Design of Software: Software Design and its Different Techniques, Software Configuration Managements. System Structuring, Control Models, Modular Decomposition, Domain-Specific Architecture.

Software Testing: Software Validation and Verification: Verification and Validation Planning, Software's Testing Strategies and Different Type of Testing Techniques, Art of Debugging.

Software Quality Assurance: Management and its Quality Assurance, Software Cognitive Fundamentals, Concepts of Software Reengineering and Web Engineering.

Advance Topics: Software Reliability Metrics, Software Reliability Specification, Statistical Testing and Reliability Growth Modeling, Use of CASE Tools and Technological Support in Engineering Software, Introduction to Unified Modeling Language–UML.

CSE 3107 **Contact Hours/week: 3**
Applied Statistics and Queuing Theory **Credits:3.00**
Prerequisite: None

Introduction: Statistics and its Importance, Population and Sample, Variable and Constants, Statistical Data, Data Collection and Presentation, Construction of Frequency Distribution and Graphical Presentation.

Measures of Central Tendency: Arithmetic Mean, Geometric Mean, Harmonic Mean, Median, Mode, Weighted Mean.

Measures of Dispersion: Range, Standard Deviation, Variance, Moments, Skewness and Kurtosis.

Correlation Theory: Linear Correlation and its Measures and Significance, Rank Correlation.

Regression Analysis: Linear and Non-Linear Regression, Least-Square Method of Curve Fittings.

Probability: Elementary Concepts, Laws of Probability – Additive and Multiplicative Law, Conditional Probability and Bay's Theorem, Random Variables, Mathematical Expectation.

Probability Distributions: Binomial Distribution, Poisson Distribution and Normal Distribution.

Queuing Theory: Stochastic Processes, Discrete Time Markov Chain and Continuous Time Markov Chain. Birth-Death Process in Queuing. Queuing Models: M/M/1,M/M/C,M/G/1,M/D/1,G/M/1 Solution of Network of Queue-Closed Queuing Models and Approximate Models. Application of Queuing Models in Computer Science.

CSE 3109 **Contact Hours/week: 3**
Microprocessors and Assembly Language **Credits:3.00**
Prerequisite: CSE 2103

Microcomputer System: Introduction to Different Types of Microprocessors and its Applications, Organization of Intel 8086/8088 Microprocessor, the Component of Microcomputer System, I/O Device, Interrupt Structures, I/O Interfacing, DMA, Co-Processors, RISC Processors, Power PC Processor, CISC Processor, Direct Video RAM Accessing, Memory Module.

Introduction of Assembly Language: Program Structure and its Components, Few Basic Instruction, Input/Output Instruction.

Flag Register and Flow Control: The Flag Register, Flow Control Instructions, Conditional and Unconditional Jumps, Branching and Looping Structures.

Logic and Arithmetic Operation: Logic, Shift and Rotate Instruction, Multiplication and Division Instructions.

Arrays and Data Structure: Arrays and Related Addressing Modes, DUP Operator, Register Indirect Modes, Based and Indexed Addressing Modes, Basic Stack Operations, Procedures Declaration, Communication between Procedures, Calling a Procedure.

String Manipulation: The String Instructions, Director Flag, Moving a String, Storing a String, Loading a String, Scanning a String, Comparing Strings, Substring Operation.

CSE 3110 **Contact Hours/week: 3**
Sessional based on CSE 3109 **Credits: 1.50**
Prerequisite: None
Sessional based on the theory of course CSE 3109.

CSE 3112 **Contact Hours/week: 3/2**
Technical Writing and Presentation **Credits: 0.75**
Prerequisite: None

Introduction: Issues of Technical Writing and Effective Oral Presentation in Computer Science and Engineering.

Writing Issues: Writing Styles of Definitions, Propositions, Theorems and Proofs; Preparation of Reports, Research Papers.

Thesis and Books: Abstract, Preface, Contents, Bibliography and Index; Writing of Book Reviews and Referee Reports.

Writing and Presentation Tools: LATEX; Diagram Drawing Software; Presentation Tools.

3rd YEAR EVEN SEMESTER

CSE 3200 **Contact Hours/week: 3/2**
Software Development Project II **Credits: 0.75**
Prerequisite: None

Students will Work in Groups or Individually to Develop High Quality Software/Projects Including New I/O Drivers or Similar Projects Involving Operating Systems Modules in Different Types of Data Base Systems or Project Oriented and Visual Languages, Students will Writes Structure Program and use Proper Documentation.

CSE 3201 **Contact Hours/week: 3**
Operating Systems **Credits: 3.00**
Prerequisite: None

Introduction to Operating System: Operating System Concepts, its Role in Computer Systems, Computer System Structure, Fundamental of Different Types of Computer System, Operating System Structure and Operation, Protection and Security.

Process Management: Process Concept, Model and Implementation, Process State, Process Scheduling, Inter-Process Communication (IPC), Multiprocessing and Timesharing, Interaction between Process and Operating System; CPU Scheduling: Scheduling Concepts, Scheduling Criteria, Scheduling Algorithms (SJF, FIFO, Round Robin, etc.).

Memory Management: Memory Portioning, with and without Swapping, Virtual Memory – Paging and Segmentation, Demand Paging, Page Replacement Algorithms, Implementation.

File Systems: FS Services, Disk Space Management, Directory and Data Structures;

Deadlocks and Case Study: Modeling, Detection and Recovery, Prevention and Avoidance; Case Study of Some Operating Systems.

Others: Introduction to the Different Smart Device Operating System and their Usage.

CSE 3202 **Contact Hours/week: 3/2**
Sessional based on CSE 3201 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 3201.

CSE 3203 **Contact Hours/week: 3**
Computer Architecture and Design **Credits: 3.00**
Prerequisite: CSE3109

Introduction to Computer Architecture: Internal Structure of Processor/CPU–Registers, PC, ALU, CU, etc. Bus Architecture and Processor Interaction with Memory and Peripherals, Memory Hierarchy in Terms of Cache Memory, Main Memory, Secondary Storage, Memory Organization into Bytes and Words; Big-Endian and Little-Endian Organization, Computer Peripherals, Introduction to Von Neumann SISD Organization, RISC and CISC Machines.

Review: Representation of Strings, Binary and Hex Integer Representations and Conversions, Signed and Unsigned Formats; 2's Complement, Computer Integer Arithmetic, Fixed-Point Arithmetic, IEEE Floating Point Representation and Arithmetic.

Process and Control: Fetch-Execute Cycle, Encoding and Decoding of MIPS Machine Instructions, the MIPS CPU Instruction Set Syntax and Semantics, Addressing Modes, MIPS Assembly Language Programming, Register Usage Conventions, use of Stack and Stack-Frame for Supporting Function Calling with Parameters, Operating System Calls and I/O Operations. CPU and its Instruction Sets Design.

Application HDL and FPGA for Microcomputer Design: Introduction to FPGA and HDL/VHDL for Digital Design Implementation.

CSE 3203 **Contact Hours/week: 3**
Computer Networks **Credits: 3.00**
Prerequisite: None

Introduction: Definition, uses of Computer Networks, Network Topology, Network Media, Network Devices, Different Types of Network: LAN, MAN, WAN etc.

IP Addressing: Classification of IP Addressing, Subnet Mask, CIDR, Private IP Address, Public IP Address, Sub Netting, VLSM etc.

Network Model: OSI Reference Model, TCP/IT Reference Model, ATM Reference Model, Functions of the Layers of Different Models, Network Protocols Working at Different Layers.

Data Link Layer Design Issues and Framing: Character Count, Byte Stuffing, Bit Stuffing, Error Detection: Cyclic Redundancy Check, Parity Bit Checking and Correction: Hamming Code, Windowing Protocols: Go Back N ARQ, Selective Repeat ARQ, Elementary Data Link Protocols, High-Level Data Link Control, Point to Point Protocol, the Medium Access Control Sub-Layer.

Multiple Access: Random Access; ALOHA, CSMA, CSMA/CD, CSMA/CA, Channelized Access, CDMA, TDMA, FDMA, Controlled Access, Reservation, Poling, Token Passing, Ethernet, Wireless Lans and Bluetooth.

Switching: Circuit Switching, Packet Switching, Message Switching, Routing Algorithms, Virtual Circuit and Datagram, Congestion Control Algorithms, Quality of Service, Internetworking, Internetworking Devices etc.
Network Layer Protocols: Address Resolution Protocol, Internet Protocol, Internet Control, Message Protocol, IPV6, Routing Information Protocol, Open Shortest Path First, Border Gateway Protocol, User Datagram Protocol, Transmission Control Protocol.

Network Security: Cryptography, Substitution Cipher, Transposition Cipher, One Time Pads, Public Key Cryptography, Encryption and Decryption, Authentication Protocol 1.0 to 5.0, Digital Signature, Key Distribution Center, Different Symmetric Key Algorithm, Certificate Authority, DNS, Electronic Mail, World Wide Web.

Others: HTTP and Recent Advances in Internet Protocols, Web Server Performance, Proxy Servers, Load Balancing in Web Servers, IP Security, Queuing Models for Networks and Protocols, Real Time Protocols such as RTP, RTCP and RTSP, Voice over IP, Cloud Computing.

CSE 3206 **Contact Hours/week: 3**
Sessional based on CSE 3205 **Credits: 1.50**
Prerequisite: None

Sessional based on the theory of course CSE 3205.

CSE 3207 **Contact Hours/week: 3**
Peripherals and Interfacings **Credits: 3.00**
Prerequisite: CSE 3109

Microprocessor Based System Design: Hardware and Software Interfacing in Microcomputer System Design, Hardware and I/O Design, Building, Debugging, Testing and Linking Program Modules, Programming EPROM.

Interfacing Components: 8284A Programmable Timer, Bus Architecture, Bus Timing, 8286 Transceiver Device, 8282 Latches, 8288 Bus Controller, Characteristics of Memory and I/O Interface, Synchronous and Asynchronous Communication, Serial I/O Interface, 8251A Communication Interface, 8255A Programmable Peripheral Interface.

Interrupt System: Sources of Interrupt, Types of Interrupt, Handling Interrupt Request, Interrupt Vector and Table, 8259A Priority Interrupt Controller, Daisy Chain.

I/O Controller and Peripheral Components: Interfacing ICs of I/O Devices, I/O Ports, Programmable Peripheral Interface, DMA Controller I.E. 8237A DMA Controller, Interrupt Controller, Communication Interface, Interval Timer, etc.

Memory Device: Memory Terminology, CPU-Memory Connections, ROM Architectures and Time Diagram, Different Type of ROM, Flash Memory, RAM Architectures and Time Diagram, Different Type of RAM and Read/Write Cycle, Programmable Logic Device Architectures.
Multi-processor Configurations: Co-Processor Configurations, Numeric Data Processor, I/O Processors.

Analog and Digital Interface: Sensors, Transducers, D/A Interface, A/D Interface, AD and DA Converters Related Chips, High Power Devices.

CSE 3208 **Contact Hours/week: 3/2**
Sessional based on CSE 3207 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 3207.

CSE 3209 **Contact Hours/week: 3**
Artificial Intelligence **Credits: 3.00**
Prerequisite: None

Fundamental: Definition of AI, Historical Development of AI, Application of AI.

Production Systems: Introduction of Product System, Production Rules, the Working Memory, the Control Unit Interpretation, Conflict Resolution Strategies, Alternative Approach for Conflict Resolution, Types of Production Systems, Forward Versus Backward Production Systems, Knowledge Base Optimization in a Production System.

General Problem Solving Approaches: Breadth First Search, Depth First Search, Iterative Deepening Search, Hill Climbing, Simulated Annealing, Heuristic Search, A* Algorithm, Adversary Search, the Minimax Algorithm, Constraint Satisfaction Problems.

Logic and Structural Knowledge Representation: Propositional Logic, First-Order Logic, Resolution Principle, Frames, Semantic-Nets, Petri Nets, Relational Data Model.

Reasoning under Uncertainty: Bayesian Reasoning, Fuzzy Knowledge, Probability Theory, Dempster-Shafer Theory, Fuzzy Set Theory, Expert Systems.

Machine Learning and Natural Language Processing: Naive Bayes Algorithm, Syntactic Semantics and Pragmatic, Top-Down Passing, Bottom-Up Pursing, Lexicon.

Programming Languages for AI Research: Historical Overview, Features of AI Programming Languages, Major AI Programming Languages LISP, PROLOG, Implementation of AI Algorithms Through PROLOG.

CSE 3210 **Contact Hours/week: 3/2**
Sessional based on CSE 3209 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 3209.

4th YEAR ODD SEMESTER

CSE 4000 **Contact Hours/week: 2**
Project / Thesis I **Credits: 1.00**
Prerequisite: None

Study of Problems in the Field of Computer Science and Engineering.
N.B. The Project/Thesis Topic Selected in this Course is to be continued in the CSE 4000 Course.

CSE 4101 **Contact Hours/week: 3**
Complier Design **Credits: 3.00**
Prerequisite: CSE 2205

Introduction to Compiler: Compiler Structure, Analysis-Synthesis Model of Compilation, Various Phases of a Compiler, Tool based Approach to Compiler Construction, Complier-Compliers and Translator Writing Systems.

Lexical Analysis: Interface with Input, Parser and Symbol Table, Token, Lexeme and Patterns, Difficulties in Lexical Analysis, Error Reporting, Implementation, Regular Definition, Transition Diagrams, Lex.

Syntax Analysis: CFGs, Ambiguity, Associativity, Precedence, Top Down Parsing, Recursive Descent Parsing, Transformation on the Grammars, Predictive Parsing, Bottom Up Parsing, Operator Precedence Grammars, LR Parsers (SLR, LALR, LR), YACC.

Syntax Directed Definitions: Inherited and Synthesized Attributes, Dependency Graph, Evaluation Order, Bottom Up and Top Down Evaluation of Attributes, L- and S-Attributed Definitions.

Type Checking: Type System, Type Expressions, Structural and Name Equivalence of Types, Type Conversion, Overloaded Functions and Operators, Polymorphic Functions.

Run Time System: Storage Organization, Activation Tree, Activation Record, Parameter Passing, Symbol Table, Dynamic Storage Allocation, and Heap Storage Management.

Intermediate Code Generation: Intermediate Representations, Translation of Declarations, Assignments, Control Flow, Boolean Expressions and Procedure Calls, Implementation Issues.

Code Generation and Instruction Selection: Issues, Basic Blocks and Flow Graphs, Register Allocation, Code Generation, Dag Representation of Programs, Code Generation from Dags, Peep Hole Optimization, Code Generator Generators, Specifications of Machine.

CSE 4102 **Contact Hours/week: 3/2**
Sessional based on CSE 4101 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4101.

CSE 4103 **Contact hours/week: 3**
Digital Signal Processing **Credits: 3.00**
Prerequisite: None

Introduction: Signals, Systems and Signal Processing, Classification of Signals, the Concept of Frequency in Continuous Time and Discrete Time Signals, Analog to Digital and Digital to Analog Conversion, Sampling and Quantization.

Discrete Time Signals and Systems: Discrete Time Signals, Discrete Time Systems, Analysis of Discrete Time Linear Time Invariant Systems. Discrete Time Systems Described by Difference Equations, Implementation of Discrete Time Systems, Correlation and Convolution of Discrete Time Signals.

The Z-Transform: Introduction, Definition of the Z-Transform, Z-Transform and ROC of Infinite Duration Sequence, Properties of Z-Transform Inversion of the Z-Transform, the One-Sided Z-Transform.

Frequency Analysis of Signals and Systems: Frequency Analysis of Continuous Time Signals, Frequency Analysis of Discrete Time Signals, Properties of Fourier Transform of Discrete Time Signals, Frequency Domain Characteristics of Linear Time Invariant System, Linear Time Invariant Systems as Frequency Selective Filters, Inverse Systems and De-convolution.

Discrete Fourier Transform (DFT): Discrete Fourier Series (DFS), Properties of DFS, Discrete Fourier Transformation (DFT), Properties and Application of DFT.

Fast Fourier Transform Algorithms: FFT Algorithms, Applications of FFT Algorithm.

Digital Filter Design Techniques: Differential and Difference Equations, Digital Transfer Functions, Frequency Response, Digital Filter Realization Scheme, Finite Impulse Response (FIR) Infinite Impulse Response (IIR) Filter Design.

Application of DSP: Speech Processing, Analysis and Coding, Matlab Application to DSP.

CSE 4104 **Contact hours/week: 3/2**
Sessional based on CSE 4103 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4103.

CSE 4105 **Contact hours/week: 3**
Digital Image Processing **Credits: 3.00**
Prerequisite: None

Digital Image Fundamentals: Different Types of Digital Images, Sampling and Quantization, Imaging Geometry, Image Acquisition Systems.

Bi-level Image Processing: Basic Concepts of Digital Distances, Distance Transform, Medial Axis Transform, Component Labeling, Thinning, Morphological Processing, Extension to Grey Scale Morphology.

Binarization of Grey Level Images: Histogram of Grey Level Images, Optimal Thresholding using Bayesian Classification, Multilevel Thresholding.

Detection of Edges : First Order and Second Order Edge Operators, Multi-Scale Edge Detection, Canny's Edge Detection Algorithm, Hough Transform for Detecting Lines and Curves, Edge Linking.

Images Enhancement: Point Processing, Spatial Filtering, Frequency Domain Filtering, Multi-Spectral Image Enhancement, Image Restoration.

Image Segmentation: Segmentation of Grey Level Images, Water Shade Algorithm for Segmenting Grey Level Image. Image Representation and Description, Recognition and Interpretation.

Image Compression: Lossy and Lossless Compression Schemes, Prediction based Compression Schemes, Vector Quantization, Sub-Band Encoding Schemes, JPEG Compression Standard, Fractal Compression Scheme, Wavelet Compression Scheme.

CSE 4106 **Contact Hours/week: 3/2**
Sessional based on CSE 4105 **Credits: 0.75**
Prerequisite: None
Sessional based on the theory of course CSE 4105.

Optional I

CSE 4107 **Contact hours/week: 3**
Information System Analysis and Design **Credits: 3.00**
Prerequisite: CSE 3105

Application Development Policy and Strategies: Planning of Information System, Policy in Information System Development, Strategies for Achieving Information System Goals.

Application System Development Life Cycle: Phases in Application System Development, Interrelationship among Each Phase.

Feasibility Assessment: Problems and Needs in Information System Development, Preliminary Application Requirements Determination, Feasibility Assessment: Economic, Technical, Operational and Schedule Feasibility.

Information Requirements Determination: Strategies for Obtaining Information Requirements, Technique for Information Requirements Determination, Methods for Providing Assurance that Requirement are Correct and Complete.

Structured Systems Analysis: Steps in Structured Systems Analysis, Activity Diagrams and Related Documentation, Data Dictionary, Problem Analysis, Structured Walk Through.

Systems Design Methodology: Check List Methodology, Process-Oriented Methodology, Application Generator, Structured Design, Program Development and Testing: Structured Programming and Method for Testing.

CSE 4108 **Contact Hours/week: 3/2**
Sessional based on CSE 4107 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4107.

CSE 4109 **Contact hours/week: 3**
Unix Programming **Credits: 3.00**
Prerequisite: None

Introduction: Introduction to Unix Programming.

Unix Environment: Command Line, Globbing, I/O Redirection, Piping, Basic Commands, Memory Layout.

Debugging: GDB, Valgrind, Essential X86, Fork, Exec, Wait, Process Status, Bit Manipulation, Sending Signals Unix I/O Implementing I/O Redirection, Piping Directories and Files. Walking a Directory Tree, Exploring Attributes. Implementing Ls-L. Permissions, File Owner / Group, Time-Stamps. Signals and Signal Handling Design / Implementation of Sleep Process Relationships Backgrounding. Popen / Pclose Midterm Terminal Handling Review Midterm Networking Client / Server. I/O Multiplexing.

Multi-threading: Basics, Mutual Exclusion Multi-Threading: Bounded Buffers, Condition Variables Multi-Threading: Deadlocks Non-Blocking I/O. Regular Expressions. Sys V IPC. Semaphores and Shared Memory. Shell Scripting.

CSE 4110 **Contact hours/week: 3/2**
Sessional based on CSE 4109 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4109.

CSE 4111 **Contact hours/week: 3**
Digital System Design **Credits: 3.00**
Prerequisite: CSE 2203

System Design: Designing I/O System; I/O Devices; Designing Microprocessor based System with Interfacing Chips.

Programmable Design: Programmable Peripheral Interface (Interface to A/D and D/A Converter); Keyboard/Display Interface; Programmable Timer; Programmable Interrupt Controller, DMA Controller.

Memory Design: Design using MSI and LSI Components; Design of Memory Subsystem using SRAM and DRAM.

Design of Various Components of a Computer: ALU, Memory and Control Unit, Hardwired and Micro Programmed; Microprocessor based Designs; Computer BUS Standards; Design Special Purpose Controllers.

CSE 4112 **Contact hours/week: 3/2**
Sessional based on CSE 4101 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4111.

CSE 4113 **Contact hours/week: 3**
Simulation and Modeling **Credits: 3.00**
Prerequisite: None

Simulation Modeling Basics: Systems, Models and Simulation; Classification of Simulation Models; Steps in a Simulation Study.

Concepts in Discrete-Event Simulation: Event-Scheduling vs. Process-Interaction Approaches, Time-Advance Mechanism, Organization of a Discrete-Event Simulation Model; Continuous Simulation Models; Combined Discreet-continuous models; Monte Carlo Simulation; Simulation of Queuing Systems.

Building Valid and Credible Simulation Models: Validation Principles and Techniques, Statistical Procedures for Comparing Real-World Observations and Simulated Outputs, Input Modeling; Generating Random Numbers and Random Variates; Output Analysis. Simulation Languages; Analysis and Modeling of Some Practical Systems.

CSE 4114 **Contact hours/week: 3/2**
Sessional based on CSE 4113 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4113.

CSE 4115 **Contact hours/week: 3**
Wireless Networks **Credits: 3.00**
Prerequisite: CSE 3205

Introduction to Wireless Networks: Wireless Access Networks, Wireless Mesh Networks, Personal Area Networks (Wireless Sensor Networks, Body Area Networks, Lowpan, and Bluetooth), Wireless and Mobile Ad Hoc Networks, Challenged Networks (Dtns,Vanets).

Wireless MAC Protocols: IEEE 802.11, IEEE 802.11e, IEEE 802.11n, IEEE 802.11s, IEEE 802.15.4, S-MAC, B-MAC, IEEE 802.22/20, IEEE 802.16d/e.

Wireless Routing: Routing Matrix – ETX, ETT, WCETT, Air Time Metric, Routing Protocols – AODV, DSR, DSDV, HWMP, Sensor Network Routing, VANET Routing etc.

Others: Wireless Transport Protocols; Wireless TCP and its Variants, Hop by Hop Congestion Control, Rate based Congestion Control etc. Quality of Service in Wireless Networks.

CSE 4116 **Contact hours/week: 3/2**
Sessional based on CSE 4116 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4115.

Optional II

CSE 4117 **Contact Hours/week: 3**
Parallel and Distributed Processing **Credits:3.00**
Prerequisite: None

Multithreaded Computing: Basic Concepts: Processes, Threads, Scheduling, Multithreaded Programming, Thread Synchronization: Semaphores, Locks, Monitors, Concurrency Issues: Deadlock, Starvation , Multi-Core Computers.

Networked Computers: Basic Concepts: Client-Server, Connections, Datagrams, Application Protocol Design, Client-Side Socket Programming, Server-Side Socket Programming, Datagram Programming.

Network Protocols and Security: Physical/Data Link/Network/Transport/Application Layers, Network Security.

Distributed Systems: Architectures: Two-Tier, Multi-Tier, Peer-To-Peer, Many-To-Many, Middleware: Distributed Objects, Web Services.

Parallel Computing: Architectures: SMP, Cluster, Hybrid, Grid, GPGPU ,Middleware: Openmp, MPI, Grid Middleware.

CSE 4119 **Contact Hours/week: 3**
Human Computer Interaction **Credits:3.00**
Prerequisite: None

Process and Model: Introduction to Human-Computer Interaction (HCI), Human Information Processing Systems, Models of Interaction, Approaches to HCI, User Interface, HCI in Software Process, Cognitive Models.

Issues and Requirements: Socio-organizational Issues and Stakeholders Requirements, Communication and Collaboration Models, Task Analysis, Dialog Notation and Design, Groupware, CSCW and Social Issues.

User System Interaction: Analysis and Design, User Interface Design, Interface Technique and Technology, Case Studies.

CSE 4121 **Contact Hours/week: 3**
Switching Systems **Credits:3.00**
Prerequisite: None

Evolution of Switching Systems: The Role of Switching Systems in Telecommunication Networks, Step by Step and Crossbar, Stored Program Control (SPC), Digital Switching, ATM Switching.

Switching System Architecture: Subscriber and Line Interface, Switching Network: Matrix and Channel Graph Representations, Blocking, Non-Blocking, and Rearrangeable Networks, Control Unit, Operation and Maintenance, Switching Process: Call Detecting, Number Analysis, Call Routing, Supervision, and Metering, Signaling Equipment.

Hardware and Software Structure of the Digital Switch: Time Switches and Space Switches, Path Searching, Processor Systems Architecture and Functions, Reliability and Fault Recovery, Man Machine Interface (MMI), Examples of the Present Digital Switching Systems.

ATM Switching Architectures and Performance: ATM Switch Architectures, Full-, and Partial-Connection Multistage Networks, Self-Routing Networks, ATM Switching.

Structures: Minimum-Depth Blocking Networks, Non-Blocking Single-, and Multiple-Queuing Networks, Arbitrary-Depth Blocking Networks, Fault-Tolerant ATM Switching Architectures.

New Trends in Switching: Photonic Switching, IP Switching.

CSE 4123 **Contact Hours/week: 3**
Control System Engineering **Credits:3.00**
Prerequisite: None

Introduction to Control System: Conventional Control System, Steady State Response to Step, Ramp, and Parabolic Inputs, Transient Response, Poles and Zeros, Frequency Response from Pole-Zero Diagram, Routh's Stability Criterion; Block Diagrams, Canonical Forms, Transfer Functions and Signal Flow Graph, Root Locus, Frequency Response, Nyquist's Stability Criterion.

Modern Control System: Introduction, State Variable Analysis, Controllability and Observability, Application of Eigen Value, Linear Control System Design by State Feedback.

Controller Design: On-Off, Fuzzy, P, PI, PD and PID Types, Introduction to Programmable Logic Controllers (PLC), Temperature Control System, Position Control System.

4th YEAR EVEN SEMESTER

CSE 4000 **Contact Hours/week: 6**
Project / Thesis II **Credits:3.00**
Prerequisite: None

Continuation of Project/Thesis Topic Under Taken in CSE 4000.

CSE 4201 **Contact Hours/week: 3**
Computer Graphics and Animations **Credits:3.00**
Prerequisite: None

Introduction: History, Application of Computer Graphics (Computer Aided Design Animation), a Survey of Graphics I/O Devices and Types.

Graphics Software Design: Survey of Desired Function, Toward a Universal Graphic Language. Display Files, Databases for Pictorial Applications.

Graphics Techniques: Point-Plotting Techniques, Line Drawing, Geometric Transformations, Windowing and Clipping, Raster Graphics.

Hardware for Computer Graphics: Typical Small and Large System, Graphic Terminals, Plotters, Graphic Display Processors, Device Independent Graphics Systems.

Graphics Software: A Simple Graphic Package, Segmented Display Files, Geometric Models, Picture Structure.

Interactive Graphics: Input Techniques, Event Handling, Three-Dimensional Graphics, Curves and Surfaces, 3-D Transformation.

Hidden Surface Problem: Back Face Removal, Hidden-Line Removal Curved Surfaces, Describing Points, Lines and Polygons, Some Hints for Building Polygonal Models, Color Perception, RGBA and Color Index Mode, Dithering, Blending, 3-D Blending with the Depth Buffer, Antialiasing, Fog, Fog Equations, the OpenGL ARB.

API Specifies: Data Types, Function Naming Conventions, Platform Independence, Drawing Shapes with OpenGL, Animation with OpenGL and GLUT.

Drawing in Space: Lines, Points and Polygons.

Co-ordinate Transformations: Understanding Transformations, Matrix Munching Projections, Matrix Manipulation Color Lighting and Materials, Texture Mapping.

CSE 4202 **Contact hours/week: 3/2**
Sessional based on CSE 4201 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4201.

CSE 4203 **Contact Hours/week: 3**
Neural Networks and Fuzzy Systems **Credits:3.00**
Prerequisite: None

Introductory Concept: Introduction Human Brain Mechanism, Neural Machine Intelligence.

Fundamental Concept of Neural Network: Basic Models of Artificial Neuron, Activation Function, Network Architecture, Neural Network Viewed as Directed Graph, Basic Learning Rules, Overview of Perceptrons, Single Layer of Perceptrons, Mathematical Model of Single Layer Perceptrons, Perceptrons Learning Algorithm, Delta Learning Rule,

Multi-Layer Perceptrons, Back Propagation Learning Algorithm, Mathematical Model of MLP Network.

Function Approximation: Basis Function Network, Radial Basis Function Networks (RBF), MLP vs. RBF Networks, Support Vector Machine (SVM).

Competitive Network and Associative Memory Network: Adaptive Resonance Theory (ART), ART-1 Architecture and Algorithm, Kohonen Self-Organizing Maps (SOMs), Linear Feed-Forward Associative Memory Network, Recurrent Associative Memory Network, Bidirectional Associative Memory Network (BAM), Hopfield Networks.

Fuzzy System: Introduction to Fuzzy System, Fuzzy Relations, Fuzzy Numbers, Linguistic Description and their Analytical Form, Fuzzy Control.

Defuzzification: Defuzzification Methods, Centroid Method, Center of Sum Method, Mean of Maxima Defuzzification, Applications, Equilibrium of Learning System, Concept of Neuro-Fuzzy and Neuro-GA Network.

Genetic Algorithm: Basic Concepts, Offspring, Encoding, Reproduction, Crossover, Mutation Operator, Application of GA.

CSE 4204 **Contact hours/week: 3/2**
Sessional based on CSE 4203 **Credits: 0.75**
Prerequisite: None

Sessional based on the theory of course CSE 4203.

CSE 4206 **Contact hours/week: 3/2**
Seminar **Credits: 0.75**
Prerequisite: None

Students will Works in Groups or Individually to Prepare Review Papers on Topics Assigned by the Teachers and will Present before Audience.

Optional I

CSE 4207 **Contact Hours/week: 3**
VLSI Design **Credits:3.00**
Prerequisite: None

VLSI Design Methodology: Top-Down Design Approach, Technology Trends.

MOS Technology: Introduction to Microelectronics and MOS Technology, Basic Electrical Properties and Circuit Design Processes of MOS and Bi CMOS Circuits,, MOS, NMOS, CMOS Inverters, Pass Transistor and Pass Gates, DC and Transient Characteristics.

Overview of Fabrication Process: NMOS, PMOS, CMOS, Bi-CMOS Process.

NMOS and CMOS Layout: Color Plate Stick Diagram, and Design Rules.

CMOS Circuit Characteristics: Resistance and Capacitance, Rise and Fall Time, Power Estimation.

Introduction to Bi-CMOS Circuits: Shifter, an ALU Sub-System, Adder, Counter, Multipliers, Multiplexer, Data Path And Memory Structures, Buffer Circuit Design, DCVS Logic.

Design and Test-Ability: Circuit Partitioning, Floor Planning and Placement, Routing, Practical Aspects of Design Tools and Test-Ability MOS Design, Behavioral Description, Structural Description, Physical Description and Design Verification.

CSE 4209 **Contact Hours/week: 3**
Impact of Computer on Society **Credits:3.00**
Prerequisite: None

Introduction: History of Computer Hardware, Software, Networking; Overview of Technological Change; Impact of Information Technology on Some Sectors.

Privacy and Personal Information: Personal Privacy, Computer Technology Effect Privacy, Moral Problems from Privacy Violation, Privacy Protection: Ethical and Legal Basis, Technological Strategies, Implications of Database Systems.

Freedom of Expression in Cyberspace: Offensive Speech and Censorship in Cyberspace, Pornography, Anonymity, Spam.

Computer & Software Reliability: Liability in Hardware and Software Failure, Responsibility s. Liability vs. Accountability, Historical Software Risks (such as the Therac-25 Case).

Intellectual Property: Intellectual Property, Copyrights, Patents, and Trade Secrets, Software Piracy, Software Patents, Pirated Software, Use of Licensed Software.

Computer Crime: History and Examples of Computer Crime; "Cracking" ("Hacking") and its Effects; Viruses, Worms, and Trojan Horses; Online Scams, Identity Theft; Moral Issues Related to These Crimes.

Computer and Work: Impact of Employment, Work Environment, Employee Monitoring, Health Issues.

Professional Ethics and Responsibilities: Ethics, Computer Ethics, Ethical Guidelines for Computer Professionals, Examine and Discuss Professional Codes of Ethics, Conduct,

and Practice (IEEE, ACM, SE, AITP, and so forth).

Optional II

CSE 4211 **Contact Hours/week: 3**
Network Planning **Credits:3.00**
Prerequisite: None

Introduction: Network components, Theoretical Network, Real World Networks.

Network Architectural Design: Designing the LAN, Configuring the Network Server and Client, Network Administration, Remote Access, Expanding the Network, Wide Area Network Troubleshooting, Major Protocol Suites.

Network Simulation: Network Simulation and Optimization, Network Operations, Control and Maintenance, Network Administration, Network Management Database and Tools, Capacity Planning.

Network Optimization: Network Security and Integrity, Linear Programming and Network Algorithms for Planning, Reliability Theory and Network Planning.

CSE 4213 **Contact Hours/week: 3**
Knowledge Engineering **Credits:3.00**
Prerequisite: None

Introduction: Key Concepts of Knowledge Representation and Reasoning, Language of First Order Logic, Syntax, Semantics Pragmatics, Expressing Knowledge, Levels of Representation, Knowledge Acquisition and Sharing, Sharing Ontologies, Language Ontologies, Language Patterns, Tools for Knowledge Acquisition.

Resolution and Reasoning: Proportional Case, Handling Variables and Qualifies, Dealing with Intractability, Reasoning with Horn Clauses, Procedural Control of Reasoning, Rules in Production, Description Logic, Vivid Knowledge, Beyond Vivid.

Representation: Object Oriented Representations, Frame Formalism, Structured Descriptions, Meaning and Entailment, Taxonomies and Classification, Inheritance, Networks, Strategies for Defensible Inheritance, Formal Account of Inheritance Networks.

Defaults, Uncertainty and Expressiveness: Closed World Reasoning, Circumscription, Default Logic Limitations of Logic, Fuzzy Logic, Non-monotonic Logic, Theories and World, Semiotics, Auto epistemic Logic, Vagueness, Uncertainty and Degrees of Belief, Noncategorical Reasoning, Objective and Subjective Probability.

Actions and Planning: Explanation and Diagnosis, Syntax, Semantics of Context, First Order Reasoning, Modal Reasoning in Context, Encapsulating Objects in Context, Agents, Actions, Situational Calculus, Frame Problem, Complex Actions, Planning, Strips – Planning as Reasoning – Hierarchical and Conditional Planning.

CSE 4215 **Contact Hours/week: 3**
Network Security **Credits:3.00**
Prerequisite: None

Introduction: Network Security Policies, Strategies and Guidelines; Network Security Assessments and Matrices.

Different Attacks: Denial of Service (Dos) Attack, Distributed Denial of Service (Ddos) Attack, Eavesdropping, IP Spoofing, Sybil Attack, Blackhole Attack, Grayhole Attack, Man-In-The-Middle Attack, Passwords-based Offline Attacks.

Network Security Threats and Attackers: Intruders, Malicious Software, Viruses and Spy-Ware; Security Standards: DES, RSA, DHA, Digital Signature Algorithm (DSA), SHA, AES; Security At Transport Layer: Secure Socket Layer (SSL) and Transport Layer Security (TLS).

Security on Network Layer: Ipsec; Network Security Applications: AAA Standards, E-Mail Securities, PGP, S/MIME; PKI Smart Cards; Sandboxing; Firewalls and Proxy Server;

Security for Wireless Network Protocols: WEP, WPA, TKIP, EAP, LEAP; Security Protocols for Ad-Hoc Network; Security Protocols for Sensor Network; Security for Communication Protocols; Security for Operating System and Mobile Agents; Security for E-Commerce; Security for LAN and WAN; Switching and Routing Security; other State-Of-The-Art Related Topics.

Optional III

CSE 4217 **Contact Hours/week: 3**
Decision Support System **Credits:3.00**
Prerequisite: None

Introduction to Decision Support System: DSS Characteristics, Applications of Decision Support Systems, Capabilities of Decision Support Systems, Components of Decision Support Systems, Benefits of using DSS Systems.

Making Decisions in the Decision Support Systems Environment: Activities in the Decision Support Systems Environment, the Decision Making Process, Information Use for Strategic Management, Making Decisions in the Decision Support Systems.

Environment: Strategic Analysis for the Organization, Types of Problems in the Decision Making Process.

Developing Decision Support System: Approaches to DSS Development, DSS Software Tools, DSS Hardware and Operating System Platforms, Building and Implementing Decision Support Systems. Decision Support Systems in Detail: Types of Decision Support Systems, DSS Models, Data Mining, Group Decision, Support Systems, Executive Information Systems (EIS). Artificial Intelligence and Expert Systems, Systems Integration and the Future of DSS: Brainstorming.

CSE 4219 **Contact Hours/week: 3**
Computer Vision **Credits:3.00**
Prerequisite: None

Introduction: Introduction to Computer Vision, Case Study-Face Recognition, Linear Algebra/Probability Review.

Image Structure: Linear Filters, Finding Lines-From Detection to Model Fitting, Clustering and Segmentation.

Camera Models: Camera Models, Camera Calibration, Epipolar Geometry, Stereo & Multi-view Reconstruction.

Recognition (Building blocks)**:** Detectors and Descriptors, SIFT & Single Object Recognition, Optical Flow & Tracking.

Recognition (Objects, Scenes, and Activities)**:** Introduction to Object Recognition and Bag-of-Words Models, Object Classification and Detection- A Part-based Generative Model (Constellation Model), Object Classification and Detection: A Part-Based Discriminative Model (Latent SVM), Human Motion Recognition.

Computer Vision: State-of-the-art and the Future.

CSE 4221 **Contact Hours/week: 3**
Data Mining **Credits:3.00**
Prerequisite: None

Data Mining and Applications: Relational Databases, Data Warehouses, Transactional Databases, Advanced Data and Information Systems, Characterization and Discrimination, Mining Frequent Patterns, Associations, and Correlations, Classification and Prediction, Cluster Analysis, Outlier Analysis, Evolution Analysis.

Data Preprocessing: Descriptive Data Summarization, Data Cleaning, Data Integration and Transformation, Data Reduction, Data Discretization and Concept Hierarchy Generation.

Classification, Clustering and Prediction: Classification by Decision Tree Induction, Bayesian Classification, Rule-Based Classification, Classification by Backpropagation, Support Vector Machines, Clustering by Partitioning/ Hierarchical/ Density-based/ Grid-based/ Model-based Methods, Clustering High-Dimensional Data, Outlier Analysis, Prediction, Linear Regression, Nonlinear Regression, Other Regression-Based Methods of Prediction, Evaluating the Accuracy and Error Measures of a Classifier or Predictor**.**

Web Mining: Anatomy of a Search Engine, Crawling the Web, Web Graph Analysis, Extracting Structured Data from the Web, Classification and Vertical Search, Web Log Analysis.

Advanced Analysis: Mining Stream, Time-Series, and Sequence Data, Graph Mining, Social Network Analysis, and Multirelational data Mining, Mining Object, Spatial, Multimedia, and Text Data.

Revised Academic Ordinance for Postgraduate Studies for the Award of Master of Science in Engineering/ Master of Engineering/Master of Philosophy/Doctor of Philosophy Degree

1. Definitions

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

2. Degrees Offered

The postgraduate degrees to be offered under this ordinance are as follows:

2.1 Master of Science in

i) Civil Engineering abbreviated as M. Sc. Engg. (CE).
ii) Electrical & Electronic Engineering abbreviated as M.Sc.Engg. (EEE).
iii) Mechanical Engineering abbreviated as M.Sc. Engg. (ME).
iv) Computer Science and Engineering abbreviated as M.ScEngg. (CSE)
v) Industrial and Production Engineering abbreviated as M.ScEngg. (IPE)

2.2 Master of Engineering in

i) Civil Engineering abbreviated as M. Engg. (CE).
ii) Electrical & Electronic Engineering abbreviated as M. Engg. (EEE).
iii) Mechanical Engineering abbreviated as M. Engg. (ME).
iv) Computer Science and Engineering abbreviated as M. Engg. (CSE)
v) Industrial and Production Engineering abbreviated as M.Engg. (IPE)

2.3 Master of Philosophy in

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

2.4 Doctor of Philosophy

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

i) Department of Civil Engineering
ii) Department of Electrical & Electronic Engineering
iii) Department of Mechanical Engineering
iv) Department of Computer Science and Engineering
v) Department of Industrial and Production Engineering
vi) Department of Mathematics
vii) Department of Physics
viii) Department of Chemistry

2.5 The above postgraduate degrees may also be offeredby other departments/discipline of the University approved by the syndicate on the recommendation of the Academic Council.

3. Admission requirements

3.1 (a) For admission to the postgraduate courses offered by the engineering faculties, a candidate must have a minimum GPA of 4.0 in the scale of 5.0 or its equivalent in the pre-university examinations.

(b) For admission to the postgraduate courses offered by the faculty of Applied Science & Engineering, a candidate must have a minimum GPA of 3.5 in the scale of 5.0 or its equivalent in the pre-university examinations.

3.2 For admission to the courses leading to the award of the Degree of M. Sc. Engg./M. Engg. in any branch of engineering, a candidate must have a B. Sc. Engg. or an equivalent degree from any recognized University/ Institute in the relevant/ related field with a minimum CGPA of 3.0 in the scale of 4.0 or its equivalent.

3.3 For admission to the courses leading to the award of M. Phil degree in any branch of Science, a candidate must have an M. Sc. or equivalent degree from any recognized University/ Institute in the relevant/related fieldwith a minimum CGPA of 3.0 in the scale of 4.0 or its equivalent in all level of the University/Institute.

3.4 For admission to the courses leading to the award of Ph. D. degree in any branch, a candidate must have an M. Sc. Engg./M. Engg./M. Phil or an equivalent degree in the relevant branch from any recognized University/Institution with a minimum CGPA of 3.25 in the scale of 4.0 or its equivalentand must fulfill the conditions of Art. 3.1 and Art.3.2 (for the Engineering faculties)/3.3 (for the faculty of Applied Science & Engineering).

3.5 If a student in M. Sc. Engg. and M. Phil program of this University shows an excellent progress and promise in thesis work, he/she may be allowed to get

admission into the Ph.D. program, on recommendation of the supervisor(s), after the successfulcompletion of their M. Sc. Engg./M. Phil degree.In such a case, the students are not required to sit for the admission test.

3.6 If the supervisor(s) is satisfied with his/her research work, a student in M. Phil program of this University may on recommendation of the supervisor(s), relevant PGAC, CASR, with the approval of the academic council, be transferred to the Ph.D. program with retrospective registration using the prescribed form. But for such transfer, the student must complete the course work requirements for a Ph. D. student and publish at least one paper in a referred/reputed Journal. In case of such a transfer, the students shall normally apply for transfer by the end of his/her 4th semester.

4. Admission Procedure

4.1 Applications for admission to the above courses shall be invited through regular means of advertisement and shall be received through prescribed application form.

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

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

4.4 Full time teachers of RUET, who applied for admission into postgraduate program of this University, are not required to sit for the admission test. All of them shall be selected for postgraduate program of this University.

4.5 Every selected candidate for the postgraduate programshall have to get himself/herself admitted/registered to the University within the prescribed time limit on payment of prescribed fees and other dues.

4.6 Eligibility for the admission of foreign students in the aforementioned postgraduate programs shall be examined by the equivalence committee.

4.7 On the recommendation of the appropriate PGAC, the rules for admission into postgraduate courses of the University may be amended from time to time by the Academic council through CASR.

5. Academic Regulations

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

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

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

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

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

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

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

5.6 **Status of a student**

5.6.1 There shall be two categories of students, namely -

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

(ii) Part Time: Students serving in different organization may be admitted as part time students with a written consent from their employer. A part time Ph. D. student shall have to take leave from his/her employer, at least two semesters (not exceeding one Calendar year) for the program; and he/she must join the program with the approved leave not later than the beginning of their fourth semester.

5.6.2 The Head of the department may allow a student to switch from part time to full time or vice versa on recommendation of the supervisor (if any). However, prior approval of the employer for such a change is required.

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

5.7 Course Registration

5.7.1 Each registered student to the postgraduate program shall be assigned by the respective PGAC, an adviser from the teachers of the department, not below the rank of an Assistant Professor having Ph. D. degree.

5.7.2 Every student in the postgraduate program shall have to register the course(s) of the current semester within the prescribed time limit on payment of prescribed fees and other dues. Prior to each registration for any semester, the Adviser/Supervisor (as appointed by Articles 9/11 of this Ordinance) shall check and approve the student's schedule for course(s), prerequisites (if any) and the total credit hours.

5.7.3 A full time M.Sc. Engg./M. Engg./M. Phil student must register a minimum of 12 credit hours and a maximum of 15 credit hours of the theory course per semester. However, a Ph. D. student may register a minimum of 9 credit hours of the theory course per semester.

5.7.4 A part time M.Sc. Engg./M. Phil/Ph. D. student must register a maximum of 6 credit hours of the theory courseper semester.However, a part time M. Engg.student may register a maximum of 9 credit hours of the theory course per semester.

5.7.5 On the approval of the supervisor, the concerned Head and the course teacher(s), postgraduate students may be allowed to register theory courses offered by any other departments of this Universityas per the following table:

Degree	Maximum allowable Theory Course	Maximum allowable Credit hours
M. ScEngg	2	6
M. Engg	4	12
M. Phil	3	9
Ph. D	1	3

5.8 Credit Transfer

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

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

5.9 Requirements for Continuation of a Program

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

5.9.2 If at the end of the 1st semester, the GPA falls below 2.5 (including C grades) he/she shall not be allowed to continue the program.

5.9.3 If a Ph. D. student fails to qualify the comprehensive examination (Art. 10) in two chances, he/she shall not be allowed to continue the program.

5.10 Minimum Credit Hour Requirements for the Degree

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

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

6. Grading System

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

.Marks obtained	Grades	Description	Grade Points
90% and above	A+	Excellent	4.0
80% to below 90%	A	Very good	3.5
70% to below 80%	B+	Good	3.0
60% to below 70%	B	Average	2.5
50% to below 60%	C	Pass	2.0

Below 50%	F	Fail	0.0
	I	Incomplete	
	S	Satisfactory	
	U	Unsatisfactory	

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

6.1.2 A student shall get I grade in a course if he/she is unable to complete the course due to any unavoidable circumstances. The student has to complete the course within the next two consecutive semesters; otherwise, he/she will get F grade in that course.

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

6.2 **Calculation of GPA and CGPA**

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

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

where n is the number of courses completed by the student in a semester with grades not less than C, Ci is the credit hour in a particular course and Gi is the grade point corresponding to the grade obtained by the student in that course.

A Cumulative Grade Point Average (CGPA) shall also be computed at the end of second and subsequent semesters. CGPA gives the cumulative performance of the student; and is computed by taking n in the above equation as the total number of courses completed by the student from first semester up to any other semester to which it refers.

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

7. Conduct of Examination of Theory Courses

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

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

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

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

8. Qualifying Requirements

8.1 The qualifying requirement of the postgraduate degree is that a student must earn a minimum CGPA of 3.0for M. Sc. Engg/ M. Engg./M. Phil and 3.25 for Ph. D.

8.2 The C grades up to a maximum of two subjects may be ignored for calculation of CGPA at the written request of the student provided he/she has fulfilled the total course credit hour requirement with the required minimum CGPA in the remaining subjects.

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

8.4 M.Sc. Engg/ M. Phil students must have a conference/journal paper from his/her thesis work.

8.5 Ph. D. students must have atleast three conference papers and should have atleast two publications from his/her thesiswork in a refferedJournal.

9. Thesis/Project for M.Sc. Engineering/M. Engg./M. Phil degree

9.1 Research work for a thesis/project shall be carried out under the supervision of a full time teacher of the department, not below the rank of Assistant Professor having Ph. D. degree. PGAC of the department will recommend the supervisor for a student in the middle of first semester. A co-supervisor (if necessary) from within or subside the department/University may also be recommended. The appointment of the supervisor and co-supervisor (if any), and the tentative research proposal of thesis/project written under the guidance of the supervisor(s)shall be approved by the CASR on recommendation of PGAC at the end of first semester of a full time and at the end of second semester of a part

time student. Accordingly, the student will have to register his/her thesis course in the following semester.

9.2 If any change in research proposal of thesis/project, the supervisor and co-supervisor (if any) is unavoidable it should be approved by the CASR on recommendation of PGAC. In such a case, if the student fails to complete the program within the specified time limit as outlined in Art. 5.1, the student may get an extension for not more than a semester.

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

9.4 A seminar shall have to be presented by M. Sc. Engg/ M. Phil student on the progress of his/her research work, within the next semester after completion of course work. The Head of the department will keep a record of it and send a copy of the same to the Vice-Chancellor in prescribed form.

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

9.6 The student shall certify that the research work was done by him/her and that the same work has not been submitted elsewhere for any degree or award (except for publication).

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

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

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

Supervisor	Chairman	
Co-Supervisor	Member	
Dean of the faculty	Member	
Head of the department	Member	
One external member from outside the department/University	External member	Two alternate names should be proposed.
One or two members from within or outside the department, not below the rank of Assistant Professor, having research experience.	Member	Three alternate names should be proposed.

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

Supervisor	Chairman	
Co-Supervisor	Member	
Dean of the faculty	Member	
Head of the department	Member	
One external member from outside the department/University	External member	Two alternate names should be proposed.
One or two member from within or outside the department, not below the rank of Assistant Professor, having research experience.	Member	Three alternate names should be proposed.

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

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

10. Comprehensive Examination for Ph.D. Student

10.1 Every Ph.D. Student shall appear at a comprehensive examination, ordinarily held soon after the completion of the course requirements. The PGAC will form an examination committee named Doctoral scrutiny Committee (DSC) through CASR approved by the academic council and will be constituted as follows:

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

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

10.2 The comprehensive examination shall comprise a written examination and/or an oral examination to test the knowledge of the student related to the subject(s) of his research and allied fields. If a student fails to qualify in a comprehensive examination, he shall be given one more chance to appear in the examination as scheduled by the PGAC. The Head of the department will send a report of the comprehensive examination in prescribed form, to the Vice-Chancellor.

11. Thesis for Ph. D. students

11.1 Research work for a thesis shall be carried out under the supervision of a full time teacher, having Ph. D. degree, of the department, not below the rank of Assistant Professor. PGAC of the department will recommend the supervisor for a student in the middle of the first semester. A co-supervisor (if necessary) from within or sutside the department/University may also be recommended. The appointment of the supervisor, co-supervisor (if any), and the title of thesis shall be approved by the CASR on recommendation of PGAC at the end of first semester of a full time and at the end of second semester of a part time student. Accordingly, the student will have to register his/her thesis course in the following semester.

11.2 If any change in research proposal of the thesis, the supervisor and co-supervisor (if any) is unavoidable it should be approved by the CASR on recommendation of PGAC. In such a case, if the student fails to complete the program within the specified time limit as outlined in Art. 5.2, the student may get an extension for not more than one academic year.

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

11.4 A seminar shall have to be presented by the student after passing the comprehensive examination. The seminar will show the evidences that the research work selected by the student is compatible towards the award of a Ph. D degree as will be evaluated by the DSC. The Head of the department will keep a record of it and send a report to the Vice-Chancellor in prescribed form.

11.5 Open seminar: Before submitting the thesis, the student will present the open seminar, showing the achievements in the research towards the award of Ph.D. degree as will be evaluated by the DSC. The Head of the department will keep a record of it and send a report to the Vice-Chancellor in prescribed form.

11.6 Every student shall submit required number of printed copies of synopsis and Thesis in prescribed format to the Head of the department, through his/her supervisor for distribution among the members of the examination committee and the experts.

11.7 The student shall certify that the research work was done by him/her and that the work has not been submitted elsewhere for degree or award (except publication).

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

11.9 The Vice-Chancellor will send the copy of the synopsis to any two experts' from the panel of whom one from outside the country, seeking their consent to be external examiner for the thesis. On receipt of their positive consent, he will send the copies of the thesis to them for evaluation and written opinion in the prescribed form.

11.10 Copies of the experts' reports may be given to the student through the supervisor, if there are any further queries to be cleared or questions to be answered by the student. Such answers should be directly sent to the expert concerned and final report should be collected.

11.11 On receipt of favorable experts' report, the supervisor in consultation with Head of the department shall propose to the Vice-Chancellor, for the approval of Academic Council, a panel of examiners for thesis and oral examination, usually one month before the date of thesis examination. The Examination Committee approved by CASR shall be constituted with the following members as described below:

Supervisor	Chairman
Other members of DSC	Members

One external member from outside the University.	External Member

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

11.13 The thesis should demonstrate and evidence of satisfactory knowledge in the field of research undertaken by the student and must be an original contribution to engineering/science and worthy of publication. In support of this the student should have at least two publications in Journal of International standard.

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

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

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

12. Cancellation of Studentship

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

13. Academic Fees

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

14. Effectiveness of this Ordinance

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

Course Structure for Postgraduate Programs of the Department of Computer Science & Engineering

Compulsory Courses		
Course No.	**Course Title**	**Credit Hours**
CSE 6000	Project (M.Sc. Engg.)	3
CSE 7000	Thesis (M.Sc. Engg.)	18
CSE 8000	Thesis (Ph.D.)	45
CSE 6001	Computer Arithmetic Analysis	3

Elective Courses		
CSE 6002	Selected Current Topics in CSE	3
CSE 6003	Selected Current Topics in CSE	3
Course No.	**Course Title**	**Credit Hours**
Algorithm and Computation		
CSE 6101	Advanced Logic Design	3
CSE 6102	Computational Geometry	3
CSE 6103	Advanced Algorithms	3
CSE 6104	Graph Theory	3
CSE 6105	Advanced Algorithmic Graph Theory	3
CSE 6106	Combinatorial Optimization	3
Computer Aided Systems Design		
CSE 6201	Advanced Computer Architecture	3
CSE 6202	Computer Organization and Design	3
CSE 6203	Advanced Microprocessors	3
CSE 6204	Multicore Architecture	3
CSE 6205	High-Performance Computer Architecture	3
CSE 6206	Real Time Systems	3
CSE 6207	Computer Aided Instrumentation and Sensor Application	3
CSE 6208	Computer Aided Optoelectronics Application	3
CSE 6209	User Interface Design and Development	3
Authentication and Recognition		
CSE 6301	Advanced Artificial Intelligence	3
CSE 6302	Soft Computing	3
CSE 6303	Machine Learning	3
CSE 6304	Pattern Recognition	3
CSE 6305	Speech Recognition	3
CSE 6306	Natural Language Processing	3
CSE 6307	Text-to-Speech Synthesis	3
CSE 6308	Machine Translation	3

CSE 6309	Evolutionary Algorithms	3
CSE 6310	Data Mining and Warehousing	3
CSE 6311	Biometrics	3
Information and Software Management		
CSE 6401	Analysis and Organization of Information Systems	3
CSE 6402	Software Quality Assurance	3
CSE 6403	Information System Audit	3
CSE 6404	Software Project Management	3
CSE 6405	Software Testing	3
CSE 6406	Geographical Information System	3
Multimedia Systems and Applications		
CSE 6501	Advanced Digital Image Processing	3
CSE 6502	Multimedia Systems	3
CSE 6503	Statistical Signal Theory	3
CSE 6504	Digital Filter Design	3
CSE 6505	Computer Animation and Virtual Reality	3
CSE 6506	Advanced Computer Graphics	3
CSE 6507	Speech Signal Processing	
Course No.	Course Title	Credit Hours
Networks and Communications		
CSE 6601	Web Technology	3
CSE 6602	Advanced Computer Networks	3
CSE 6603	Wireless Sensor Networks	3
CSE 6604	Wireless Ad Hoc Networks	3
CSE 6605	Mobile Computing	3
CSE 6606	Wireless Resource Management	3
CSE 6607	Optical Fiber System	3
CSE 6608	Optical Fiber Communication	3
CSE 6609	Satellite Communication	3
CSE 6610	Computer Ethics	3
Database and Computer Systems		
CSE 6701	Advanced Database Management System	3
CSE 6702	High Dimensional Data Management	3
CSE 6703	Distributed Database Systems	3
CSE 6704	Parallel Computing	3
CSE 6705	Embedded Systems	3
CSE 6706	Advanced Operating Systems	3
CSE 6707	Optimization Techniques for Compilers	3

Detail Syllabus

CSE 6001 **Contact Hours/week: 3**
Computer Arithmetic Analysis **Credit: 3**

Integer Arithmetic, Floating Point Arithmetic; Single Precision and Double Precision; Interrupt Handling High-Speed Adders; Standard and Recorded Multipliers, Booth's Multiplier, Canonical and Multi Bit Scanning Multipliers, Array Multipliers; High Radix Non-Restoring Division, SKT Division, Robertson Division, Convergence Division and Cellular Array Dividers; Floating Point Processors; Binary Squares and Square Roots, Evaluation of Trigonometric Functions and Polynomials, Chen Convergence Computation, CORD1C Computations, Logarithmic Number System (LNS) Processor.

CSE 6101 **Contact Hours/week: 3**
Advanced Logic Design **Credit: 3**

Functional Decomposition and Symmetric Functions; Linear Sequential Machines; Reed-Muller Expansions and their Minimizations; XOR based Logic Design; Self-Timed Circuits; Asynchronous Design Techniques; Digital Logic Circuit Testing and Testable Design: Testing of Combinational and Sequential Logic Circuits, Design for Testability and Built-In Self Test; Digital Logic Simulation.

CSE 6102 **Contact Hours/week: 3**
Computational Geometry **Credit: 3**

Searching and Geometric Data Structures : Balanced Binary Search Trees, Priority-Search Trees, Range Searching, Interval Trees, Segment Trees, Algorithms and Complexity of Fundamental Geometric Objects: Polygon Triangulation and Art Gallery Theorem, Polygon Partitioning, Convex-Hulls 2- and 3- Dimension, Dynamic Convex-Hulls; Geometric Intersection: Line Segment Intersection and the Plane-Sweep Algorithm, Intersection of Polygons; Proximity: Voronoi Diagrams, Delunay Triangulations, Closest and Furthest Pair: Visualization: Hidden Surface Removal and Binary Space Partition (BSP) Trees; Graph Drawings: Drawings of Rooted Trees (Layering, Radial Drawings, HV-Drawings, Recursive Winding), Drawings of Planar Graphs (Straight-Line Drawings, Orthogonal Drawing, Visibility Drawings); Survey of Recent Developments in Computational Geometry.

CSE 6103 **Contact Hours/week: 3**
Advanced Algorithms **Credit: 3**

Randomized Algorithms: Las Vegas and Monte Carlo Algorithms; Randomized Data Structures: Skip Lists; Amortized Analysis: Different Methods, Applications in Fibonacci Heaps; Lower Bounds: Decision Trees, Information Theoretic Lower Bounds, Adversary

Arguments; Approximation Algorithms: Approximation Schemes, Hardness of Approximation; Fixed Parameter Tractability: Parameterized Complexity, Techniques of Designing Fixed Parameter Algorithms, Examples; Online Algorithms: Competitive Analysis, Online Paging Problem, K-Server Problem; External Memory Algorithms; Advanced Data Structures: Linear and Non-Linear Methods.

CSE 6104 **Contact Hours/week: 3**
Graph Theory **Credit: 3**

Introduction: Fundamental Concepts, Trees, Spanning Trees In Graphs, Distance in Graphs, Eulerian Graphs, Digraphs, Matching and Factors, Cuts and Connectivity, K-Connected Graphs; Network Flow Problems; Graph Coloring: Vertex Coloring and Edge Coloring, Line Graphs, Hamiltonian Cycles, Planar Graphs, Perfect Graphs.

CSE 6105 **Contact Hours/week: 3**
Advanced Algorithmic Graph Theory **Credit: 3**

Vertex Orderings: St-Numbering and Canonical Orderings; Graph Decompositions and Their Algorithmic Applications: Ear Decomposition, Canonical Decomposition, Tree Decomposition, Path Width and Tree Width, PQ-Tree, SPQR-Tree, Split Decomposition, Recursively Decomposable Graphs, Clique Separator Decomposition; Graph Representations: Implicit Representations, Intersection and Containment Representations; Graph Classes Defined by Forbidden Subgraphs; Graph Classes Defined by Elimination Schemes; Classes of Graphs with Bounded Treewidth and their Algorithmic Implications; Characterization, Construction and Recognition Algorithms for Some Special Classes of Graphs.

CSE 6106 **Contact Hours/week: 3**
Combinatorial Optimization **Credit: 3**

Introduction to Optimization; Linear Programming: Different Forms, Simplex Method, Primal-Dual Theory; Max-Flow: the Max-Flow-Min-Cut Theorem, Ford-Fulkerson Labeling Algorithm, Dijkstra's Algorithm, the Floyd-Warshall Algorithm; Some Network Flow Algorithms: the Minimum Cost Network Flow Method, Transportation Problem; Capacitated Transportation Problem, Assignment Problem; Integer Linear Programming; Relaxation; Cutting-Plane Algorithm; Branch and Bound Technique; Dynamic Programming; NP-Completeness; TSP and Heuristics; Approximation.

CSE 6201 **Contact Hours/week: 3**
Advanced Computer Architecture **Credit: 3**

Introduction to High Performance Computing: Overview, Pipeline vs Parallel Processing; Parallel Architectures: Classification and Performance; Pipeline Processing: Pipeline Performance, Design of Arithmetic Pipelines, Multifiction Pipes, Concept of Reservation Table, Collision Vector and Hazards; Instruction Processing Pipes: Instruction and Data Hazard, Hazard Detection and Resolution, Delayed Jumps, Delayed Execution; RISC Philosophy; Pipeline Scheduling Theory: Greedy Pipeline Scheduling Algorithm, State Diagram, Modified State Diagram, Latency Cycles, Optimal Cycles, Scheduling of Static and Dynamic Pipelines; Implementation of Pipeline Schedulers Interconnection Networks: Interconnection Network Classification, Single Stage/ Multistage Networks, Crossbars, Clos Networks, Benes Networks, Routing Algorithms; Omega, Cub-Connected and other Networks.

CSE 6202 **Contact Hours/week: 3**
Computer Organization and Design **Credit: 3**

Classification and Addressing Modes, Operands and Operations for Media and Signal Processing, Instructions for Control Flow, Encoding an Instruction Set; Pipelined and Superscalar Processors, Data Hazards, Dynamic Scheduling, Branch Prediction, Hardware based Speculation, Thread Level Parallelism; ILP with Software Approaches: Compiler Techniques, Static Branch Prediction, Static Multiple Issue, Advanced Compiler Support for ILP; Basic Techniques of Integer Arithmetic, Floating-Point Arithmetic, Speeding up Integer Addition, Speeding up Integer Multiplication and Division; Memory Technology, Raids, Organization for Improving Performance, Virtual Memory and Protection, Cache Organization, Reducing Cache Miss Rate and Penalty; Busses, Performance Measures, Designing I/O System, Reliability, Dependability and Availability; Symmetric Shared Memory Architectures, Cache Coherence Protocols, Distributed Shared Memory Architectures, Synchronization, Models for Memory Consistency, Multithreading. Interconnection Networks- Practical Issues, Network on Chip, Designing Cluster; Advanced RISC, CISC and Embedded Processors Architectures.

CSE 6203 **Contact Hours/week: 3**
Advanced Microprocessors **Credit: 3**

Review of Different Microprocessors: 80486, 68040, V70, Gmicro Processors; Comparing the Architectures: RISC and CISC; Instruction Set of Machines: SPARC, INTEL, and MIPS; Study of Microprocessors: Pentium II, Alpha 21064, MIS 6400, PA-RISC; Math Coprocessors and Microprocessors.

CSE 6204 **Contact Hours/week: 3**
Multicore Architecture **Credit: 3**

Fundamentals of Superscalar Processor Design; Limitations of ILP, Super Scalar Processor Design, Multi Threading, Thread Level Parallelism; Introduction to Multicore Architecture; Multicore vs MultiThreading, Symmetric Shared Memory Architectures, Distributed Shared Memory Architectures, Issues Related to Multicore Caches, Design of Mutlicore Core Caches, Levels of Caches, Cache Optimization, Models of Memory Consistency, Virtual Memory; Cache Coherence Protocols (MSI, MESI, MOESI), Scalable Cache Coherence, Snoop-based Multiprocessor Design: Correctness Requirements, Design with Single-Level Caches and an Atomic Bus, Multilevel Cache Hierarchies,

Dealing with Split-Transaction Bus, Coherence for Shared Caches and Virtually Indexed Caches, TLB Coherence Overview of Directory based Approaches, Design Challenges of Directory Protocols, Memory based Directory Protocols, Cache based Directory Protocols, Protocol Design Tradeoffs, Synchronization; Powerpc Architecture; RISC Design, Powerpc ISA, Powerpc Memory Management, Power 5 Multicore Architecture Design, Power 6 Architecture; Cell Broad Band Engine Architecture, PPE (Power Processor Element), SPE (Synergistic Processing Element) Interconnection Network Design; Interconnection Topologies, Routing Techniques, Flow Control Mechanisms, Router Architecture, Arbitration Logic.

CSE 6205 **Contact Hours/week: 3**
High-Performance Computer Architecture **Credit: 3**

Basic Principles and Techniques in the Design of High Performance Computer Architecture; Memory Architecture: Cache Structure and Design, Virtual Memory Structures; Pipelined Processor Architecture; Pipeline Control and Hazard Resolution, Pipelined Memory Structures, Interrupt, Evaluation Techniques; Vector Processing, RISC and CISC Architecture; VLSI Architecture Issues.

CSE 6206 **Contact Hours/week: 3**
Real Time Systems **Credit: 3**

Introduction: Hard Versus Soft Real Time Systems, Jobs and Processors, Deadlines and Timing Constraints, Hard and Soft Timing Constraints, a Reference Model of Real Time Systems: Processors and Resources, Temporal Parameters of Real Time Workload, Periodic Task Model, Precedence Constraints and Data Dependency, other Types of Dependencies, Functional Parameters, Resource Parameters of Jobs and Parameters of Resources, Scheduling Hierarchy; Commonly used Approaches to Real Time Scheduling: Clock Driven Approach, Weighted Round Robin Approach, Priority Driven Approach, Dynamic Versus Static Systems, Effective Release Times and Deadlines, Optimality of EDF and LST, Challenges in Validating Timing Constraints in Priority Driven Systems, Offline Versus Online Scheduling, Clock Driven Scheduling: Notations and Assumptions, Static Timer Driven Scheduler, General Structure of Cyclic Schedules, Cyclic Executives, Improving Average Response Time of Aperiodic Jobs, Scheduling Sporadic Jobs; Priority Driven Scheduling of Periodic Jobs: Static Assumptions, Fixed Priority Versus Dynamic Priority Algorithms, Maximum Schedulable Utilization, Optimality of RM and DM Algorithms, Schedulability Test for Fixed Priority Tasks with Short Response Times, Schedulability Test for Fixed Priority Tasks with Arbitrary Response Times, Sufficient Schedulability Conditions for RM and DM Algorithms; Scheduling Aperiodic and Sporadic Jobs in Priority Driven Systems: Assumptions and Approaches, Deferrable Servers, Sporadic Servers, Constant Utilization; Resources and Resource Access Control: Assumptions on Resources and their Usage, Effects of Resource Contention and Resource Access Control, non Preemptive Critical Sections, Basic Priority Inheritance Protocol, Basic Priority Ceiling Protocol, Stack based Priority Ceiling Protocol, Preemption Ceiling Protocol.

CSE 6207 **Contact Hours/week: 3**
Computer Aided Instrumentation and Sensor Application **Credit: 3**

Review of Different Types of Sensors and their Operation Characteristics; Signal Conditioning and Driver Circuits; ADC and DAC Applications; Signal Multiplexing, Interfacing Techniques Interfacing External Circuit with PC, Serial and Parallel Port, Port Programming, Reading Data from Outside PC, Sending Data to Port Loop and Closed Loop Instrumentation; Practical Examples Dealing with Linear and Angular Displacement, Force, Light, Temperature and Acoustic Signals; Introduction to Different Types of Standard Interfacing Bus such as GPIB, HPIB IEEE488 etc.

CSE 6208 **Contact Hours/week: 3**
Computer Aided Optoelectronics Application **Credit: 3**

Elements of Optoelectronics Light and Laser Light; Laser System; Photo Detectors; Radiometry and Light Coupling Systems and Applications; Fiber Optics Telephone Link, Optical Imaging using CCD Cameras; Laser Scanning Camera, Interfacing Camera with PC.

CSE 6209 **Contact Hours/week: 3**
User Interface Design and Development **Credit: 3**

Human-Computer Interaction and the Importance of Good Interface Design; Interface Quality and Methods of Evaluation; Prototyping and Implementation Techniques. Task Analysis and Iterative Design Cycle; Dialog Techniques, Basic Computer Graphics, Use of Color and Sound; I/O Device; Menus and their Use; Command Languages; Screen Formatting; Natural Language Facilities.

CSE 6301 **Contact Hours/week: 3**
Advanced Artificial Intelligence **Credit: 3**

Introduction; Advanced Search Techniques in AI, Knowledge based System Design; Advanced Plan Generating Systems; Bayesian Network and Probabilistic Reasoning; Learning in Neural Belief Networks; Practical Natural Language Processing; Computer Vision; Introduction to Robotics.

CSE 6302 **Contact Hours/week: 3**
Soft Computing **Credit: 3**

Introduction to Soft-Computing Tools, Fuzzy Logic, Genetic Algorithms, Neural Networks and Probabilistic Reasoning; Application of Fuzzy Logic Concepts in Engineering Problems; Engineering Optimization Problem Solving using Genetic Algorithms; Neural

Network Approaches in Engineering Analysis, Design and Diagnostics Problems; Applications of Probabilistic Reasoning Approaches.

CSE 6303 **Contact Hours/week: 3**
Machine Learning **Credit: 3**

Prediction as Regression and Classification; Bias-Variance Tradeoff Non-Parametric Approaches; Max-Margin and Support Vector Machines Basics of PAC Learning; Model Averaging and Ensembles Unsupervised Learning; Time Series Analysis and Prediction Sequential Models; Hidden Markov Models; Semi Supervised Learning, Graphical Models.

CSE 6304 **Contact Hours/week: 3**
Pattern Recognition **Credit: 3**

Introduction to Pattern Recognition and Applications to OCR, Speech Recognition, Fingerprints, Signatures etc; Commercial Importance of Applications; Introduction to Statistical, Neural and Structural Approaches; Statistical Pattern Recognition: Patterns and Classification, Discriminant Functions, Bayes Decision Rule, Nearest Neighbor Rule, Probability of Error; Linear Discriminant Functions: Perceptrons and Training, LMSE Approaches; Unsupervised Learning and Clustering; Feature Extraction; Neural Approach: Introduction to Artificial Neural Networks, Feed Forward Networks, Delta Rule and Back Propagation, Hopfield Networks and Unsupervised Learning, Adaptive Resonance Architectures, Related Techniques; Pattern Associators and Content Addressable Memories, Hardware Realizations; Syntactic Pattern Recognition: Formal Languages and Grammars Pattern Grammars and Higher Dimensional Grammars, Parsing, Automata Realizations, Stochastic Grammars, Grammatical Inference, Computational Learning Theory, Valiant's Framework.

CSE 6305 **Contact Hours/week: 3**
Speech Recognition **Credit: 3**

Introduction; Speech Signal: Production, Perception and Characterization, Signal Processing and Analysis; Pattern Comparison Techniques: Distortion Measures, Spectral-Distortion Measures, Time Alignment and Normalization; Recognition System Design and Implementation: Source-Coding, Template Training, Performance Analysis; Connected Word Models: Two Level DP, Level Building Algorithm, One-Pass Algorithm; Continuous Speech Recognition: Sub Word Units, Statistical Modeling, Context-Dependent Units; Task Oriented Models.

CSE 6306 **Contact Hours/week: 3**
Natural Language Processing **Credit: 3**

A Computational Framework for Natural Language; a Framework such as LFG, GPSG or Panlni in Some Depth; Partial Description of English or an Bengali Language in the Framework, Lexicon, Algorithms and Data Structures for Implementation of the Framework; Introduction to Semantics and Knowledge Representation; Some Applications like Machine Translation, Database Interface.

CSE 6307 **Contact Hours/week: 3**
Text-to-Speech Synthesis **Credit: 3**

Introduction and Definition, Composition and Production of Speech; Human Hearing, Acoustics and Phonetics; Text Parsing and Processing: Grammars and Lexicons, Segmentation, Transducers; Morphological and Contextual Analysis; Phonetization: Phonemes, Modules and Systems; Intonation and Prosody: Levels, Acoustic, Perceptual and Linguistic Models, Prosodic Parsing; Techniques: Architectures, Formalisms, Databases, Rule Based, Formant, Concatenative, Linear Predictive and Stochastic Synthesis.

CSE 6308 **Contact Hours/week: 3**
Machine Translation **Credit: 3**

Theoretical Problems: Definition, Context Dependency, Interpretation and Translation; Engineering Problems of Machine Translation: Maintainability, Tunability, Modularity and Efficiency; Linguistics-based MT: Compositionality and Isomorphism, Declarative Frameworks, Constraint-based Formalisms; Knowledge-based MT: Translation and Understanding, Design of Interlinguas, the Conceptual Lexicon; Statistics-based MT: E-M Algorithms, Alignment Of Bilingual Corpora, Translation Templates; Example-based MT: Similarity Measures, Levels of Comparison; Treatment of Context Dependency: Knowledge-based Transfer, Sublanguage-based MT, Translation Units.

CSE 6309 **Contact Hours/week: 3**
Evolutionary Algorithms **Credit: 3**

Introduction to Evolutionary Algorithm; Selection: Rank-based, Roulette Wheel, Stochastic, Local, Truncation and Tournament; Recombination: Discrete, Real Valued and Binary Valued; Mutation: Real Valued and Binary Valued; Reinsertion: Global and Local; Population Models; Co-Evolution: Cooperative and Competitive; Learnable Evolution Model; Fast Evolutionary Programming; Application of Evolutionary Algorithms to: System Design, Telecommunication, Robotics and other Industrial Areas.

CSE 6310 **Contact Hours/week: 3**
Data Mining and Warehousing **Credit: 3**

Basic Concept of Data Mining, Issues and Techniques; Data Warehouse and OLTP Technologies for Data Mining, Classification of Data Mining Techniques and Models, Data Pre-Processing, Data Mining Primitives, Query Languages and System Architecture, Characterization and Comparison; Mining Association Rules in Large Database; Cluster

Analysis, Multidimensional Analysis and Descriptive Mining of Complex Data Object; Data Mining in Distributed Heterogeneous Database Systems; Data Mining Applications and Future Research Issues.

CSE 6311 **Contact Hours/week: 3**
Biometrics **Credit: 3**

Overview of Biometrics: Biometric Identification, Biometric Verification, Biometric Enrollment, Biometric, System Security; Authentication and Biometrics: Secure Authentication Protocols, Access Control Security Services, Authentication Methods, Authentication Protocols, Matching Biometric Samples, Verification by Humans; Common Biometrics: Finger Print Recognition, Face Recognition, Speaker Recognition, Iris Recognition, Hand Geometry, Signature Verification, Positive and Negative of Biometrics; Matching: Kinds of Errors, Score Distribution, Estimating Errors from Data, Error Rate of Match Engines.

CSE 6401 **Contact Hours/week: 3**
Analysis and Organization of Information Systems **Credit: 3**

Organization Aad Representation of Information and Access to Information; Categorization, Indexing and Content Analysis; Use of Codes, Formats and Standards; Analysis and Evaluation of Search and Navigation Techniques; Project Management and Scheduling; Analysis of Information Needs and Systems Requirements; Design of Alternatives; Quantitative Methods and Tools for Decision Making; Documentation Management; Social and Behavioral Aspects of Information Production.

CSE 6402 **Contact Hours/week: 3**
Software Quality Assurance **Credit: 3**

Definition and Concept of Software Quality Assurance (SQA); Quality Models; Specification of Quality Requirements; Product Development and Delivery Issues; Software Development Processes and Maturity; Software Quality Management Process: Total Quality Management, Improvement Cycle, SQA Planning and Management, Organizing the SQA Effort; Software Verification and Validation; Typical Software Development Errors; Fagan Inspections; Software Audit; Software Testing: Testing Objectives and Testing Fundamentals, Testing Theory, Coverage Criteria, Equivalence Class Testing, Value-based Testing, Decision Table, Syntax and State Transition Testing, Statement and Path Testing, Branch and Condition Testing, Data Flow Testing, Thread-based Testing, Integration and Integration Testing, System Testing; Testing in Object-Oriented Systems; Test Tools and Test Automation; Test Management; Problem Reporting and Corrective Action.

CSE 6403 **Contact Hours/week: 3**
Information System Audit **Credit: 3**

Introduction; The Information Systems (IS) Audit Process, Management, Planning, and Organization of IS; Technical Infrastructure and Operational Practices and Infrastructure; Protection of Information Assets, Disaster Recovery and Business Continuity; Business Application System Development, Acquisition, Implementation and Maintenance; Business Process Evaluation and Risk Management.

CSE 6404 **Contact Hours/week: 3**
Software Project Management **Credit: 3**

Overview of Project Management; Project Tracking and Scheduling; Risk Management and Analysis; Cost Estimation Models; Project Metrics; Function Point Estimation; Software Quality Assurance; Program Verification and Validation Techniques; Software Testing Techniques, Black-Box and White-Box Techniques; Testing of Various Areas: Unit, Domain, Path, Equivalent Class based Portion, Component, Aggregation, System Testing, Requirement based Testing, Acceptance Testing; Software Reuse and Maintenance; Industrial Practices in Software Engineering; ISO Certification Standards for Software Quality Assurance; Software Capability Maturity Model and its Impact.

CSE 6405 **Contact Hours/week: 3**
Software Testing **Credit: 3**

Objectives of Software Testing, Test Process, Testing and Development, Test Case, Test Execution, Test Harness, Testing and Debugging, Test Adequacy, Control Flow Graph, Errors, Faults and Failures, Types of Testing; Test Generation from Requirements: Equivalence Partitioning, Boundary Value Analysis, Category Partitioning, Fault Model for Predicates, Boolean Operator (BOR), Boolean Relational Operator (BRO) and Boolean and Relational Expression (BRE) Methods, Limitations of Test Generation from Requirements; Test Adequacy Assessment: Adequacy Criteria, Control Flow based Criteria, Data Flow based Criteria, Mutation based Criteria, Adequacy as a Stopping Criterion, Adequacy as a Tool for Test Enhancement; GUI Testing, Security Testing, Random Testing, Combinatorial Testing; Testing Tools: Open Source and Commercial Software Testing Tools.

CSE 6406 **Contact Hours/week: 3**
Geographical Information System **Credit: 3**

Introduction to GIS/LIS, Database Design and Development, Feature Extraction from Satellite Imagery, Data Acquisition using GPS, Spatial Analysis, Digital Cartography and Visualization.

CSE 6501 **Contact Hours/week: 3**
Advanced Digital Image Processing **Credit: 3**

Image Sampling and Quantization; Image Smoothing, Sharpening and Contrast Enhancement in Spatial and Frequency Domains: Basic Gray Level Transformation, Histogram Processing, Image Subtraction, Image Averaging, Gaussian and Laplacian Filters in Spatial and Frequency Domains, Convolution Theorem; Image De-Noising: Noise Models, Noise Reduction by Spatial and Frequency Domain Filters, Mean Filter, Adaptive Filter, Bandpass and Band Reject Filters, Notch Filter, Inverse Filter, Minimum Mean Square Error Filter; Multi-Resolution Image Processing: Wavelet Transform in One and Two Dimensions, Tree Structured Wavelet Transform, Pyramid Structured Wavelet Transform, Curvelet Transform; Morphological Image Processing: Erosion, Dilation, Opening, Closing, Hole Filling, Connected Components, Thinning, Skeletons, Extension of Morphological Operations to Gray Scale Images; Image Segmentation: Thresholding, Region based Segmentation, Contour based Segmentation, Graph based Segmentation; Color Image Processing: Color Models and Transformations, Edge Detection and Segmentation in Color Images, Color Image Compression; Digital Image Security; Image Content Feature Extraction, Representation and Image Retrieval; Concept Learning and Object Recognition.

CSE 6502 **Contact Hours/week: 3**
Multimedia Systems **Credit: 3**

Overview to Multimedia Systems; Multimedia Storage; Data Compression Techniques for Audio and Video; Synchronization; Multimedia Networking and Protocols; QOS Principles; Video Streams on ATM; Mobile Multimedia Communications; Operating System Support for Multimedia; Hypermedia System; Standards for Multimedia; Multimedia Database and Multimedia Applications.

CSE 6503 **Contact Hours/week: 3**
Statistical Signal Theory **Credit: 3**

Representation of Deterministic Signals: Orthogonal Representation of Signals; Dimensionality of Signal Spaces; Construction of Orthogonal Basis Functions; Time-Bandwidth Relationship: RMS Duration and Bandwidth, Uncertainty Relations; Random Processes: Definition and Classification, Stochastic Integrals, Fourier Transforms of Random Processes, Stationary and Non-Stationary Processes, Correlation Functions; Ergodicity, Power Spectral Density, Transformations of Random Processes by Linear Systems; Representation of Random Processes (Via Sampling, K-L Expansion and Narrow Band Representations), Special Random Processes (White Gaussian Noise, Wiener-Levy Processes, Shot-Noise Processes, Markov Processes); Optimum Filtering : Matched Filters for Deterministic Signals in White and Colored Gaussian Noise; Wiener Filters for Random Signals in White and Colored Gaussian Noise; Discrete and Continuous Time Filters.

CSE 6504 **Contact Hours/week: 3**
Digital Filter Design **Credit: 3**

Discrete Time Signals and Systems Z Transforms; Structures for Digital Filters; Designs Procedures for FIR and IIR Filters.

CSE 6505 **Contact Hours/week: 3**
Computer Animation and Virtual Reality **Credit: 3**

Introduction to Virtual Reality, Virtual Reality Systems, Real-Time Computer Graphics, Overview of Application Areas; Virtual Reality Systems: Virtual Environment, Computer Environment, VR Technology, Modes of Interaction; Virtual Reality Hardware: Sensor Hardware, Display Systems, Acoustic Hardware, Integrated VR Systems; Virtual Reality Software: Modeling of Virtual Worlds, Simulation, VR Toolkits; 3D Computer Graphics: the Virtual World Space, Perspective Projection, Stereo Vision, 3D Clipping, Colour Theory, 3D Modeling, Illumination Models, Shading Algorithms, Hidden Surface Removal, Realism; Geometrical Transforms; Frames of Reference, 3D Transforms, Instances, Picking, Flying, Scaling the VE, Collision Detection; Animating the Virtual Environment: Animation, the Dynamics of Numbers, Updating Real-Time Graphics, Shape and Object Inbetweening, Free-Form Deformation; Human Factors: Perception, Persistence of Vision, Stereopsis, Sound Perseption, Equilibrium; Physical Simulation: Simulation of Physical Systems, Mathematical Modeling, Collisions, Projectiles, Introduction to Dynamics, Motion Kinematics.

CSE 6506 **Contact Hours/week: 3**
Advanced Computer Graphics **Credit: 3**

Computer Graphics: Introduction to Computer Graphics, Mathematical Foundations, 2D Translation, Scaling, Rotation and Shear, Windowing Transformations, Instance Transformations, Structured Graphics; 3D Translation, Scaling, Rotation; Multimedia: Introduction to Multimedia, Presentation Graphics, Desktop Publishing, Production Planning and Design, User Interface Design, Hypermedia Authoring Concepts, Multimedia Sound, File Compression, JPEG, MPEG, Digital Video, Designing Web-based Multimedia, Multimedia Distribution.

CSE 6507 **Contact Hours/week: 3**
Speech Signal Processing **Credit: 3**

Production and Classification of Speech Sounds; Pole-Zero Models; Homomorphic Signal Processing; Short-Time Fourier Transform Analysis and Synthesis; Filter-Bank Analysis and Synthesis, Sinusoidal Analysis and Synthesis; Pitch Estimation and Speech Coding; Speech Recognition and Synthesis.

CSE 6601 **Contact Hours/week: 3**
Web Technology **Credit: 3**

Introduction to Advanced Web Technology; Technological Issues: XML Processing, RDF Processing, Middleware Technologies (CORBA, IIOP), RMI, RPC; Taxonomies and Ontologies for Advanced Web Applications: Ontology Modeling, Languages for Representing Ontologies on the Web, Rules and Inferences; Web Services, Design and Modeling of Web Services, Technologies for Implementing Web Services; Current Applications of Advanced Web Technologies.

CSE 6602 **Contact Hours/week: 3**
Advanced Computer Networks **Credit: 3**

Overview of OSI Model, TCP/IP, Circuit Switching and Packet Switching, Multiplexing, Routing and Congestion Control and Deadlock Prevention; Driving Forces for High Speed Networking, High Speed Lans, Fast Ethernet and Gigabit Ethernet, FDDI and DQDB, Frame Relay Architecture, Standards and Protocols, Switched Multi Megabit Data Services, ATM Standards Protocols, ATM Lans, Optical Communication and SONET/SDH, Broadband Access Technologies, X-DSL; BISDN Protocol and Architecture, Broadband Service Aspects and Access Architecture, Broadband Transmission Networks, Broadband Intelligent Network; Broadband Access Network Technology, Encryption and Network Security, Advanced Topics for Network Management.

CSE 6603 **Contact Hours/week: 3**
Wireless Sensor Networks **Credit: 3**

Introduction: Applications; Localization and Tracking: Tracking Multiple Objects; Medium Access Control: S-MAC, IEEE 802.15.4 and Zigbee; Geographic and Energy-Aware Routing; Attribute-based Routing: Directed Diffusion, Rumor Routing, Geographic Hash Tables; Infrastructure Establishment: Topology Control, Clustering, Time Synchronization; Sensor Tasking and Control: Task-Driven Sensing, Information-based Sensor Tasking, Joint Routing and Information Aggregation; Sensor Network Databases: Challenges, Querying the Physical Environment, In-Network Aggregation, Data Indices and Range Queries, Distributed Hierarchical Aggregation; Sensor Network Platforms and Tools: Sensor Node Hardware, Sensor Network Programming Challenges.

CSE 6604 **Contact Hours/week: 3**
Wireless Ad Hoc Networks **Credit: 3**

Introduction: Applications and Motivations; Broadcasting Protocols: Algorithmic Aspect, Optimization Techniques, Power-Efficient Broadcasting; Routing Protocols: DSDV, AODV, DSR, Position based Routing Protocols, Load Balancing Techniques, Multi-Path Routing; Medium Access Control Protocols: Reservation-based MAC Protocols, Bluetooth Technology, IEEE 802.11 based MAC Protocols; Channel Propagation Models; Topology Control Protocols; Power Aware Protocol Design; Cross Layer Design Principles; Mobility Awareness; Fairness and Security Issues: Attacks and Preventions; Stimulating Cooperation: Self Policing Schemes, Economic Incentive based Schemes.

CSE 6605 **Contact Hours/week: 3**
Mobile Computing **Credit: 3**

Cellular Networks: Channel Allocation, Multiple Access, Location Management, Handoffs; Wireless Networking: Wireless Transmission Basics, MAC Protocols, Routing, Transport, Ad-Hoc Networking; Applications: Mobility Adaptations, Disconnected Operations, Data Broadcasting, Mobile Agents; others: Security, Energy Efficient Computing, Impact of Mobility on Algorithms.

CSE 6606 **Contact Hours/week: 3**
Wireless Resource Management **Credit: 3**

Resource Management Architecture: Evolution and Components of Qos and Cross-Layer Architecture for Bandwidth Management; Tri-Band and Smart Antenna; Handoff Management; Mobility Prediction; Resource Management and Connection Admission Control; Bandwidth Allocation and Scheduling: Real-Time Guaranteed and Fair Real-Time Scheduling; Inter-Domain Radio Resource Management; High Performance Broadband Architecture; Wireless Truthful Computing; Resource Allocation of Spatio-Temporal Division Multiple Access Control; Resource Management Schemes for Connectivity: Piconet and Scatternet; Energy Efficient MAC Layer Protocols for Wireless Ad-Hoc Networks; Routing and Resource Discovery for Wireless Ad-Hoc Networks: Qos based Routing, Topology Management, Efficient Resource Discovery, Hybrid Routing Protocols and Localization; Energy Efficient Broadcasting and Multicasting Algorithms; Power-Conserving Broadcasting and Multicasting Algorithms; Scopes of Increasing Wireless Resources, Research and Future Developments.

CSE 6607 **Contact Hours/week: 3**
Optical Fiber System **Credit: 3**

Review of Semiconductor Physics: Radiative Recombination; Leds, Optical Cavity, DH and other Lasers; P-I-N and APD Detectors, Detector Noise; Optical Fibers: Ray and Mode Theories, Multimode and Single-Mode Fibers, Attenuation, Dispersion. Gaussian Beams; Power Coupling, Splices and Connectors.

CSE 6608 **Contact Hours/week: 3**
Optical Fiber Communication **Credit: 3**

Fiber Optic Transmitter and Receiver Designs; Link Analyses; Line Coding; Coherent Optical Communication Systems; Multiplexing Schemes; Local Area Networks, FDDI,

SONET and SDH; Fiber Optic Sensors and Signal Processing; Optical Amplifiers; Photonic Switching; Solutions in Optical Fibers.

CSE 6609 **Contact Hours/week: 3**
Satellite Communication **Credit: 3**

Introduction; Historical Background and Overall Perspective; Satellite Network Modeling; Link Calculations; FM Analysis; TV Transmission; Digital Modulation; Error Control; Multiple Access; FDMA, TDMA, CDMA; Orbital Considerations; Launching; Atmospheric Effects; Transponders; Earth Stations; VSATs.

CSE 6610 **Contact Hours/week: 3**
Computer Ethics **Credit: 3**

Responsibilities of Computer Scientists: Responsibilities Influences by Growth in Computer Use and Networks, Professional and Ethical Responsibilities; Intellectual Property; Piracy; Hacking, Viruses, Liability, Privacy, Crime and Civil Liabilities.

CSE 6701 **Contact Hours/week: 3**
Advanced Database Management System **Credit: 3**

Physical Storage and Indexing Structures; Query Processing Algorithms, Query Optimization; Transaction Processing and Serializability, Concurrency Control, Recovery, Parallel and Distributed Databases; Xquery and XML Query Evaluation; Emerging Database Trends, Data Mining, Data Warehousing, Object Oriented Database, Spatial and Temporal Database.

CSE 6702 **Contact Hours/week: 3**
High Dimensional Data Management **Credit: 3**

Spatial Database Systems; Spatial Data Types; Indexing and Querying Spatial Data; Spatial Networks; Temporal Database Systems; Moving Object Data Management Systems; Moving Object Indexing Techniques; Query Processing on Moving Object Data; Multidimensional Indexing Methods; Similarity Search; Dimension Reduction Methods; Time Series Data; Indexing Techniques for Massive Time Series Data; State-Of-The-Art Systems for Managing High Dimensional Data; Emerging Issues in High-Dimensional Data Management Systems.

CSE 6703 **Contact Hours/week: 3**
Distributed Database Systems **Credit: 3**

Relational Database Theory, Query Processing and Optimization; Recovery Techniques, Concurrency Control; Crash Recovery; Distributed Database Systems: Security and Integrity; Database Paradigms: Deductive and Object Oriented Issues; Heterogeneous Databases.

CSE 6704 **Contact Hours/week: 3**
Parallel Computing **Credit: 3**

Fundamental Theoretical Issues in Designing Parallel Algorithms and Architectures; Parallel Computers based on Interconnection Networks such as Hyper Cubes, Shuffle-Exchanges, Trees, Meshes and Butterfly Networks; Parallel Algorithms for Arithmetic, Linear Algebra, Sorting, Fourier Transform, Recurrence Evaluation and Dense Graph Problems; Use of Graph Embedding Techniques to Compare Different Networks; Shared Memory based Parallel Computers; Algorithms for List Ranking, Maximal Independent Set, Arithmetic Expression Evaluation, Convex Hull Problems and others; Message Routing on Multidimensional Meshes, Butterfly Networks, Hyper Cubes, Shuffle Exchange Networks, Fat-Trees and others; Simulation of Shared Memory on Networks; Routing on Expander-based Networks; Limits to Parallelizability and P-Completeness; Thompson Grid Model for VLSI; Layouts for Standard Interconnection Networks; Lower Bound Techniques for Area and Area Time-Squared Tradeoffs; Area-Universal Networks.

CSE 6705 **Contact Hours/week: 3**
Embedded Systems **Credit: 3**

Introduction to Embedded Systems, Hardware/Software Code Sign, Embedded Micro Controller Cores, Embedded Memories, Examples of Embedded Systems, Sensors and Interfacing Techniques, Real-Time Concepts, Real-Time Operating Systems, Required RTOS Services/Capabilities (in Contrast with Traditional OS); Resource Management/Scheduling Paradigms: Static Priorities, Static Schedules, Dynamic Scheduling, Best Effort Current Best Practice in Scheduling (E.G. Rate Monotonic Vs. Static Schedules); Real World Issues: Blocking, Unpredictability, Interrupts, Caching; Examples of Oss for Embedded Systems: RT Linux, VRTX. Programming Languages for Embedded Systems E.G., Handel-C and Esterel, System Support for Embedded Systems, Selected Embedded System-based Applications: Processcontrol, Robotics, etc; Software Development Methodology: Model based Development, Statecharts, etc. Case Studies, Controlling an Injection Molding Process, Flight Simulator, Digital Call Center Handler, Codec.

CSE 6706 **Contact Hours/week: 3**
Advanced Operating Systems **Credit: 3**

In-Depth Analysis of Advanced Topics of Operating Systems: Performance Analysis of Memory Management and Scheduling Algorithms; Advanced Virtual Memory Issues; Advanced Issues in Interprocess Communication; File System Design; Multiprocessor and Distributed Operating Systems: Highly Concurrent Machines; Distributed Synchronization and Resource Allocation Algorithms; Distributed File System and Transactions, Security Issues; Interfaces with Network Protocols.

CSE 6707 **Contact Hours/week: 3**

Optimization Techniques for Compilers **Credit: 3**

Control Flow and Data-Flow Analysis, Program Optimisation and Code Generation Across Basic Blocks, Procedures and Complete Programs; Interprocedural and Intraprocedural Analysis, Intermediate Representations, Register Allocation and Scheduling in the Context of Modern Uniprocessors; Dependence Analysis and Loop Transformations: Building Blocks for Optimising for Memory Hierarchies and Parallel Machines.

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