



Academic Catalogue

Bachelor of Science in Computer Science and Engineering
for
Academic Year 2023–24 (onwards)

Department of Computer Science and Engineering (CSE)
Islamic University of Technology (IUT)
Organisation of Islamic Cooperation (OIC)

August 2024

Contents

Part I

General Information

Chapter 1

Department Information

1.1 Brief History

The department of Computer Science and Engineering (CSE) started its journey as the department of Computer Science and Information Technology (CIT) in 1998. It has always proactively responded to the ever changing technological market demand. At beginning, the course curricula were organized to include more Information Systems and database courses. The department soon included web based application development courses to meet the demand of the Internet age. When the telecommunication industry was booming and demanded human resources skilled in mobile and telecommunications and it responded to the trend. However, it was felt that solutions involving hardware and software are the key to drive the market which was established by the technology giants. Hence the department was transformed as Computer Science and Engineering (CSE) in 2013 to emphasize on engineering aspects of computing.

The product based technology industry are bringing new solutions involving hardware and software; however the domination in the market share mostly depends on the strength of the ported software and its ability to connect with the other solutions. Therefore, the need for software engineers is ever-growing. To produce good software engineers, the department of CSE has started a separate bachelor program namely B.Sc. in Software Engineering in 2017. Software is shipped to many different platforms: computers, mobile, web, manufacturing devices, avionics, medical devices, and everywhere. The requirements, design, architecture, and technologies are so diverse that a bunch of new courses are included in the syllabus of the software engineering bachelors curriculum.

Currently, the department has 40 full-time faculty members along with 7 part-time faculty members from other reputed universities. In addition to this, 17 faculty mem-

bers are on leave for higher education in abroad. There are about more than 650 undergraduate and more than 30 graduate students in the department.

1.2 Vision and Missions of the Department

1.2.1 Vision

To be an outstanding provider of future leaders and workforce in Computer Science and Software Engineering.

1.2.2 Missions

The missions of the CSE department are:

1. To impart quality education in the undergraduate and postgraduate levels.
2. To provide a balanced curriculum that focuses on the theory and application of computer science and software engineering to the dynamically changing technological world.
3. To excel in research and innovation integrating the faculty knowledge and student skills.
4. To prepare students with necessary communication skills pertaining to successful careers in leadership positions.

1.3 Programs Offered by the Department

1. Doctor of Philosophy in Computer Science and Engineering, Ph.D. (CSE)
2. Master of Science in Computer Science and Engineering, M.Sc. Engg. (CSE)
3. Master of Engineering in Computer Science and Engineering, M. Engg. (CSE)
4. Bachelor of Science in Computer Science and Engineering, B.Sc. Engg. (CSE)
5. Bachelor of Science in Software Engineering, B.Sc. (SWE)

Chapter 2

Program Information

The Bachelor of Science in Computer Science and Engineering, abbreviated as B.Sc. Engg. (CSE), is the preferred degree both for graduate study in computer science and for technical careers in software development. Our curricula, faculty, and research areas focus on an array of topics including network and communications, algorithms and complexity, artificial intelligence and machine learning, bioinformatics, computer architecture and design, databases and data mining, privacy and cryptography, and human-computer interaction. Students majoring in CSE should have shown considerable ability in mathematics and logical reasoning. In view of that, a number of courses on Mathematics and Basic Science have been included in the syllabus. In addition, some social science, management, accounting, economics, and communication-skills development-related courses have been incorporated to make the syllabus a balanced and reasonably complete one. The objective of this undergraduate program in Computer Science and Engineering is to develop skilled and competent graduates to meet the current and future needs at home and abroad. To achieve that goal, our students, faculty and staff are continuing to work together to build an even stronger department. To benefit from academics, students must live in an open, accepting, and compassionate community that encourages the exploration of ideas. We are a department that prides itself as a home for high-quality education and research, and, as always, a home for our students and alumni.

2.1 Program Educational Objectives (PEOs)

Students graduating from the Bachelor of Science in Computer Science and Engineering (B. Sc. in CSE) program, upon graduation, will have the ability to:

1. Demonstrate the ability to apply computing and analytical approaches to analyze, design, and develop solutions and conduct cutting-edge research.

2. Demonstrate professionalism, understand and carry the ethical values for the welfare of society, Muslim Ummah, and beyond.
3. Demonstrate strong awareness for life-long learning through self-motivation, professional training, and higher education.
4. Demonstrate the skill for effective communication, ability to interact with people of diverse educational and cultural background and work individually or in a team.

2.2 Program Outcomes (POs)

1. Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem Analysis: Identify, formulate, research, and analyze complex engineering problems and reach substantiated conclusions using the principles of mathematics, the natural sciences, and the engineering sciences.
3. Design/Development of Solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety and of cultural, societal, and environmental concerns.
4. Investigation: Conduct investigations of complex problems, considering experimental design, data analysis, and interpretation, and information synthesis to provide valid conclusions.
5. Modern Tool Usage: Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities with an understanding of their limitations.
6. The Engineer and Society: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. Environment and Sustainability: Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate the knowledge of and need for sustainable development.
8. Ethics: Apply ethical principles and commit to the professional ethics, responsibilities and norms of the engineering practice.
9. Individual Work and Teamwork: Function effectively as an individual and as a member or leader of diverse teams and in multidisciplinary settings.

10. **Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of engineering and management principles and apply these to ones work as a team member or a leader to manage projects in multidisciplinary environments.
12. **Life-Long Learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change.

2.3 Assessment and Grading Systems

2.3.1 Distribution of Marks

The performance of a student in a course is evaluated based on a scheme of continuous assessment, mid semester, and semester final examinations. For theory courses, this continuous assessment is made through a set of quizzes, class participation, and assignments. The assessment in laboratory/sessional courses is made through observation of the students and viva voce during laboratory hours, and quizzes. The distribution of marks in the continuous assessment, mid semester, and semester final examinations is as follows:

Module	Percentage (%)
Quizzes and assignments	20
Mid semester	40
Semester final	40

2.3.2 Letter Grades

Letter grades and corresponding grade points are awarded in accordance with the provisions shown below:

Grade	Equivalent Grade Point	Numerical Markings
A+	4.00	80% and above
A	3.75	75% to below 80%
A-	3.50	70% to below 75%
B+	3.25	65% to below 70%
B	3.00	60% to below 65%
B-	2.75	55% to below 60%
C+	2.50	50% to below 55%
C	2.25	45% to below 50%
D	2.00	40% to below 45%
F	0.00	below 40%

2.3.3 Assignment of Credits

Each theory or lab course is assigned a weekly contact hours. The credit hours of a course are directly related to the weekly contact hours of the course. The credit hours of a theory course are equal to the weekly contact hours of the course, the credit hours of a lab course are half of the weekly contact hours of the course. One contact hour refers to a 50-minute class in each week of a semester.

2.3.4 Grade Point Average

The overall academic progress of a student in a semester is assessed by calculating grade point average (GPA). The grade points obtained by a student in a course is the product of the credit hours of the course and the equivalent grade point corresponding to the letter grade obtained by the student in that course. Grade Point Average (GPA) is the weighted average of the grade points obtained in all the courses passed/completed by a student.

$$GPA = \frac{1}{\sum C_i} \sum_{i=1}^n (C_i \times GP_i)$$

where,

n = Number of courses offered in a semester

C_i = Credit hours of the i^{th} course

GP_i = Grade point obtained in the i^{th} course

2.3.5 Attendance Requirement

A student is required to attend at least 85% of the classes held in each course of a semester. The students failing to attend the requisite percentage of classes in

any course will not be allowed to appear at the Semester Final Examinations in the semester. In special circumstances, the Vice-Chancellor on the recommendation of the Head of the Department may condone 10% of the required attendance on grounds of serious illness of the student on the production of a certificate by a Registered Physician, or reasons acceptable to the Vice-Chancellor.

Chapter 3

Faculty Members of the Department

3.1 Active Faculty Members

Sl.	Name	Designation	Email@iut-dhaka.edu
1.	Dr. Md. Hasanul Kabir	Professor and Head	hasanul
2.	Muhammad Mahbub Alam, Ph.D.	Professor	mma
3.	Dr. Abu Raihan Mostofa Kamal	Professor	raihan.kamal
4.	Dr. Md. Kamrul Hasan	Professor	hasank
5.	Dr. Hasan Mahmud	Associate Professor	hasan
6.	Dr. Md. Sakhawat Hossen	Associate Professor	sakhawat
7.	Dr. Md. Azam Hossain	Associate Professor	azam
8.	Tareque Mohmud Chowdhury	Assistant Professor	tareque
9.	Shohel Ahmed	Assistant Professor	a.shohel
10.	Dr. Md. Moniruzzaman	Assistant Professor	milton
11.	Lutfun Nahar Lota	Assistant Professor	lota
12.	Ashraful Alam Khan	Assistant Professor	ashraful
13.	Md. Hamjajul Ashmafee	Assistant Professor	ashmafee
14.	Faisal Hussain	Assistant Professor	faisalhussain
15.	Mohammad Ridwan Kabir	Assistant Professor	ridwankabir
16.	Sabbir Ahmed	Assistant Professor	sabbirahmed
17.	Md. Jubair Ibna Mostafa	Assistant Professor	jubair
18.	Md. Mohsinul Kabir	Assistant Professor	mohsinulkabir
19.	Md. Bakhtiar Hasan	Assistant Professor	bakhtiarhasan

Sl.	Name	Designation	Email@iut-dhaka.edu
20.	Md. Nazmul Haque	Assistant Professor	nazmul.haque
21.	Njayou Youssouf	Lecturer	njayou
22.	Tanjila Alam Sathi	Lecturer	tanjilaalam187
23.	Shahriar Ivan	Lecturer	shahriarivan
24.	S.M. Sabit Bananee	Lecturer	smsabitbananee
25.	Imtiaj Ahmed Chowdhury	Lecturer	imtiajahmed
26.	Mohammad Ishrak Abedin	Lecturer	ishrakabedin
27.	Jibon Naher	Lecturer	jibon.naher09
28.	Md. Rafid Haque	Lecturer	rafidhoque
29.	Zannatun Naim Sristy	Lecturer	zannatunnaim
30.	Ali Abir Shuvro	Lecturer	aliabir
31.	Maliha Noushin Raida	Lecturer	malihanoushin
32.	Md. Shihab Shahriar	Lecturer	shihabshahriar
33.	Mueeze Al Mushabbir	Lecturer	almushabbir
34.	Asaduzzaman Herok	Lecturer	asaduzzaman34
35.	Ishmam Tashdeed	Lecturer	ishmamtashdeed
36.	Farzana Tabassum	Lecturer	farzana
37.	Md Farhan Ishmam	Lecturer	farhanishmam
38.	Sabrina Islam	Lecturer	sabrinaislam22
39.	Md. Atiqur Rahman	Lecturer	atiqurrahman23
40.	Syed Rifat Raiyan	Lecturer	rifatraiyan

3.2 Faculty Members on Leave

Sl.	Name	Designation	Email@iut-dhaka.edu
1.	Tajkia Rahman Toma	Assistant Professor	tajkiatoma
2.	Md. Mohayeminul Islam	Assistant Professor	mohayemin
3.	A.B.M. Ashikur Rahman	Assistant Professor	ashikiut
4.	Sadia Sharmin	Assistant Professor	sharmin
5.	Ahnaf Munir	Assistant Professor	ahnaf
6.	Tasnim Ahmed	Assistant Professor	tasnimahmed
7.	Abed Rahman	Lecturer	abed
8.	Rafsanjany Kushol	Lecturer	kushol
9.	Raihan Islam Arnob	Lecturer	raihanislam
10.	Md. Redwan Karim Sony	Lecturer	redwankarim

Sl.	Name	Designation	Email@iut-dhaka.edu
11.	Fardin Saad	Lecturer	fardinsaad
12.	Md. Mezbaur Rahman	Lecturer	mezbaurrahman
13.	Md. Mezbaur Rahman	Lecturer	mezbaurrahman
14.	Mohammad Anas Jawad	Lecturer	anasjawad
15.	Nafisa Sadaf Hriti	Lecturer	nafisasadaf
16.	Md. Zahidul Islam	Lecturer	zahidulislam
17.	Mohammed Saidul Islam	Lecturer	saidulislam

3.3 Part-Time Faculty Members

Sl.	Name	Affiliation	Email
1.	Dr. Obaidur Rahman	Professor Department of CSE Dhaka University of Engineering and Technology	orahman- @duet.ac.bd
2.	Dr. Md. Abdul Hakim Khan	Professor Department of Math- ematics Bangladesh Univer- sity of Engineering and Technology	mahkhan- @math.buet.ac.bd
3.	Dr. Md. Dalilur Rahaman	Professor Department of Physics University of Dhaka	dalilurrahaman.phy- @du.ac.bd
4.	Dr. Md. Azizar Rahman	Associate Professor Department of Physics Bangladesh Univer- sity of Engineering and Technology	azizar- @phyu.buet.ac.bd

Sl.	Name	Affiliation	Email
5.	Razib Hayat Khan, Ph.D.	Associate Professor Department of Com- puter Science and Engineering Independent Univer- sity, Bangladesh	rkhan- @iub.edu.bd
6.	Dr. Md Mostofa Kamal Rasel	Associate Professor Department of CSE East West University	mostofa.kamal- @ewubd.edu
7.	Dr. Muntasir Alam	Assistant Professor Department of Ap- plied Mathematics University of Dhaka	muntasir.appmath- @du.ac.bd
8.	Dr. Rijaul Karim Madani	Senior Teacher Kulliyatul Quranil Kareem Waddirasatil Islamiyah	aburaiyan2010- @gmail.com

Part II

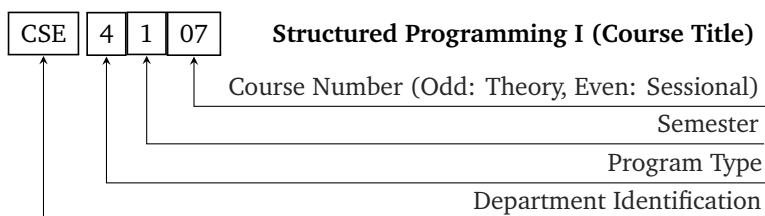
Academic Catalogue

Chapter 4

Course Code Details

Each course is designated by a three-letter code identifying the department/program of the course followed by a four-digit number. If the course is offered by an academic department, The four-digit number represents the followings:

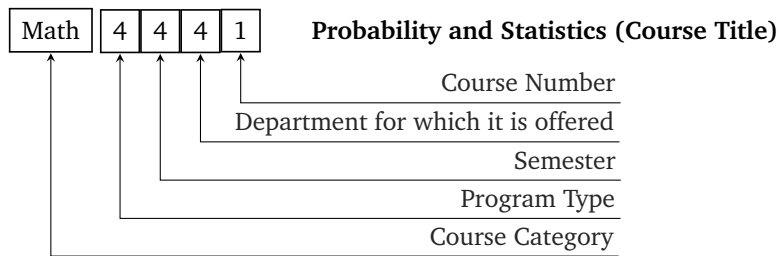
- The first digit corresponds to the program type. For example, 4 indicates B.Sc. four year program.
- The second digit corresponds to the semester in which the course is normally taken by the students.
- The final two digits refer to the number of the course, where an odd number indicates a theory course and an even number indicates a sessional/lab course.



For Humanities, Mathematics, Physics, and Chemistry courses, a three/four-letter code identifies the type of the course which is followed by a four-digit number. The four-digit number represents the followings:

- The first digit corresponds to Program type. For example 4 indicates B.Sc. four year program.

- The second digit corresponds to the semester in which the course is normally taken by the students.
- The third digit represents the department for which the course is offered.
- The final digit refers to the number of the course, where an odd number represents a theory course and an even number indicates a sessional/Lab course.



Chapter 5

Course Structure

L = Lecture, P = Practical

First Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
Hum 4145	Islamiat	2.0-0	2.00
Hum 4147	Technology, Environment and Society	3.0-0	3.00
Math 4141	Geometry and Differential Calculus	4.0-0	4.00
Phy 4141	Physics I	3.0-0	3.00
CSE 4105	Computing for Engineers	3.0-0	3.00
CSE 4107	Structured Programming I	3.0-0	3.00
Hum 4142/ Hum 4144	Arabic I/ English I	0-2.0	1.00
Phy 4142	Physics I Lab	0-1.5	0.75
CSE 4104	Engineering Drawing Lab	0-1.5	0.75
CSE 4108	Structured Programming I Lab	0-3.0	1.50
Total		18-8.00	22.00

Second Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
Hum 4241	Islamic History Science and Culture	2.0-0	2.00
Math 4241	Integral Calculus and Differential Equations	4.0-0	4.00
Phy 4241	Physics II	3.0-0	3.00
Chem 4241	Chemistry	3.0-0	3.00
CSE 4203	Discrete Mathematics	3.0-0	3.00
CSE 4205	Digital Logic Design	3.0-0	3.00
Hum 4242/ Hum 4244	Arabic II/ English II	0-2.0	1.00
Phy 4242	Physics II Lab	0-1.5	0.75
Chem 4242	Chemistry Lab	0-1.5	0.75
CSE 4202	Structured Programming II Lab	0-3.0	1.50
CSE 4206	Digital Logic Design Lab	0-1.5	0.75
Total		18-9.50	22.75

Third Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
Math 4341	Linear Algebra	3.0-0	3.00
EEE 4383	Electronic Devices and Circuits	3.0-0	3.00
CSE 4301	Object Oriented Programming	3.0-0	3.00
CSE 4303	Data Structures	3.0-0	3.00
CSE 4305	Computer Organization and Architecture	3.0-0	3.00
CSE 4307	Database Management Systems	3.0-0	3.00
EEE 4384	Electronic Devices and Circuits Lab	0-1.5	0.75
CSE 4302	Object Oriented Programming Lab	0-3.0	1.50
CSE 4304	Data Structures Lab	0-3.0	1.50
CSE 4308	Database Management Systems Lab	0-2.0	1.00
Total		18-9.50	22.75

Fourth Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
Hum 4441	Engineering Ethics	3.0-0	3.00
Math 4441	Probability and Statistics	3.0-0	3.00
EEE 4483	Digital Electronics and Pulse Techniques	3.0-0	3.00
CSE 4403	Algorithms	3.0-0	3.00
CSE 4405	Data and Telecommunications	4.0-0	4.00
CSE 4407	System Analysis and Design	2.0-0	2.00
EEE 4484	Digital Electronics and Pulse Techniques Lab	0-1.5	0.75
CSE 4402	Visual Programming Lab	0-3.0	1.50
CSE 4404	Algorithms Lab	0-2.0	1.00
CSE 4408	System Analysis and Design Lab	0-2.0	1.00
Total		18-8.50	22.25

Fifth Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4501	Operating Systems	3.0-0	3.00
CSE 4503	Microprocessor and Assembly Language	3.0-0	3.00
CSE 4511	Computer Networks	3.0-0	3.00
CSE 4513	Software Engineering and Object-Oriented Design	3.0-0	3.00
	Elective 5-I	3.0-0	3.00
	Elective 5-II	3.0-0	3.00
CSE 4502	Operating Systems Lab	0-2.0	1.00
CSE 4504	Microprocessor and Assembly Language Lab	0-1.5	0.75
CSE 4508	RDBMS Programming Lab	0-3.0	1.50
CSE 4510	Software Development	0-1.5	0.75
CSE 4512	Computer Networks Lab	0-3.0	1.50
	Elective 5-II Lab	0-1.5	0.75
Total		18-12.50	24.25

Elective 5-I

Course Code	Course Title	Contact Hour L-P	Credit Hour
Math 4541	Multivariable Calculus and Complex Variables	3.0-0	3.00
CSE 4531	E-Commerce and Web Security	3.0-0	3.00
CSE 4537	Decision Support Systems	3.0-0	3.00
CSE 4547	Parallel and Distributed Systems	3.0-0	3.00

Elective 5-II

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4539	Web Programming	3.0-0	3.00
CSE 4543	Geographical Information Systems	3.0-0	3.00
CSE 4549	Simulation and Modeling	3.0-0	3.00
CSE 4551	Computer Graphics and Multimedia Systems	3.0-0	3.00
CSE 4540	Web Programming Lab	0-1.5	0.75
CSE 4544	Geographical Information Systems Lab	0-1.5	0.75
CSE 4550	Simulation and Modeling Lab	0-1.5	0.75
CSE 4552	Computer Graphics and Multimedia Systems Lab	0-1.5	0.75

Sixth Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
Hum 4641	Accounting	3.0-0	3.00
CSE 4615	Wireless Networks	2.0-0	2.00
CSE 4619	Peripherals and Interfacing	3.0-0	3.00
CSE 4621	Machine Learning	3.0-0	3.00
	Elective 6-I	3.0-0	3.00
	Elective 6-II	3.0-0	3.00
CSE 4610	Design Project	0-3.0	1.50
CSE 4614	Technical Report Writing	0-1.5	0.75
CSE 4616	Wireless Networks Lab	0-1.5	0.75
CSE 4620	Peripherals and Interfacing Lab	0-1.5	0.75
CSE 4622	Machine Learning Lab	0-1.5	0.75
	Elective 6-I Lab	0-1.5	0.75
	Elective 6-II Lab	0-1.5	0.75
Total		17-12.00	23.00

Elective 6-I

Course Code	Course Title	Contact Hour L-P	Credit Hour
Math 4641	Numerical Methods	3.0-0	3.00
CSE 4641	Distributed Operating Systems	3.0-0	3.00
CSE 4643	Mobile Application Development	3.0-0	3.00
CSE 4647	Distributed Database Systems	3.0-0	3.00
Math 4642	Numerical Methods Lab	0-1.5	0.75
CSE 4642	Distributed Operating Systems Lab	0-1.5	0.75
CSE 4644	Mobile Application Development Lab	0-1.5	0.75
CSE 4648	Distributed Database Systems Lab	0-1.5	0.75

Elective 6-II

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4631	Digital Signal Processing	3.0-0	3.00
CSE 4635	Web Architecture	3.0-0	3.00
CSE 4649	Systems Programming	3.0-0	3.00
CSE 4651	Unix Programming	3.0-0	3.00
CSE 4632	Digital Signal Processing Lab	0-1.5	0.75
CSE 4636	Web Architecture Lab	0-1.5	0.75
CSE 4650	Systems Programming Lab	0-1.5	0.75
CSE 4652	Unix Programming Lab	0-1.5	0.75

Seventh Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
Hum 4741/ Hum 4743/ Hum 4745	Business Communication and Law/ Engineering Economics/ International Relationship	2.0-0	2.00
Math 4741	Mathematical Analysis	3.0-0	3.00
CSE 4703	Theory of Computing	3.0-0	3.00
CSE 4711	Artificial Intelligence	3.0-0	3.00
	Elective 7-I	3.0-0	3.00
	Elective 7-II	3.0-0	3.00
CSE 4712	Artificial Intelligence Lab	0-1.5	0.75
	Elective 7-II Lab	0-1.5	0.75
CSE 4700	Project/Thesis	0-6.0	3.00
CSE 4790	Industrial Training	0-2.0	1.00
Total		17-11.00	22.50

Elective 7-I

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4739	Data Mining	3.0-0	3.00
CSE 4743	Cryptography and Network Security	3.0-0	3.00
CSE 4745	Embedded Systems Design	3.0-0	3.00
CSE 4747	Computational Biology	3.0-0	3.00

Elective 7-II

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4733	Digital Image Processing	3.0-0	3.00
CSE 4735	Digital Systems Design	3.0-0	3.00
CSE 4749	Introduction to Cloud Computing	3.0-0	3.00
CSE 4751	Network Programming	3.0-0	3.00
CSE 4753	Bioinformatics	3.0-0	3.00
CSE 4734	Digital Image Processing Lab	0-1.5	0.75
CSE 4736	Digital Systems Design Lab	0-1.5	0.75
CSE 4750	Introduction to Cloud Computing Lab	0-1.5	0.75
CSE 4752	Network Programming Lab	0-1.5	0.75
CSE 4754	Bioinformatics Lab	0-1.5	0.75

Eighth Semester

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4801	Compiler Design	3.0-0	3.00
CSE 4803	Graph Theory	3.0-0	3.00
CSE 4807	IT Organization and Management	3.0-0	3.00
CSE 4809	Algorithm Engineering	2.0-0	2.00
	Elective 8-I	3.0-0	3.00
	Elective 8-II	3.0-0	3.00
CSE 4802	Compiler Design Lab	0-1.5	0.75
CSE 4810	Algorithm Engineering Lab	0-1.5	0.75
	Elective 8-II Lab	0-1.5	0.75
CSE 4800	Project/Thesis	0-6.0	3.00
Total		17-10.50	22.25

Elective 8-I

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4841	Introduction to Optimization	3.0-0	3.00
CSE 4845	Introduction to Information Retrieval	3.0-0	3.00
CSE 4847	Information and OS Security	3.0-0	3.00
CSE 4849	Human Computer Interaction	3.0-0	3.00
CSE 4851	Design Pattern	3.0-0	3.00

Elective 8-II

Course Code	Course Title	Contact Hour L-P	Credit Hour
CSE 4833	VLSI Design and Testing	3.0-0	3.00
CSE 4835	Pattern Recognition	3.0-0	3.00
CSE 4839	Internetworking Protocols	3.0-0	3.00
CSE 4834	VLSI Design and Testing Lab	0-1.5	0.75
CSE 4836	Pattern Recognition Lab	0-1.5	0.75
CSE 4840	Internetworking Protocols Lab	0-1.5	0.75

Chapter 6

Detailed Course Description

First Semester

Hum 4145

Islamiat

Credit: 2.00

Tawheed: Tawheedul Uluhia, Tawheedul Rububia and Tawheedul Asma-was-sifat, Aqeedah/creeds of Islam: Creeds of Ahlus-sunnah-wal-jamah; Sources of Islamic Code of Life; Social, Economic and Political system of Islam; Islamic ethics and Moral values: Human values in Islam, Dignity Family Ties; Role of Islam in eradicating social evils; Islam and the world peace.

Recommended Texts:

1. A. A. B. Philips, *The fundamentals of tawheed (Islamic monotheism)*, 2nd ed. International Islamic Publishing House, 2006

Hum 4147

Technology, Environment and Society

Credit: 3.00

Definition of terminology - technology, environment, society and development; Inter-dependence of technology, environment, society and development; Growth of technologies and its contribution to human development; Current state of technology and its future use as an instrument of change in twenty first century; Impact of technology upon the environment, impact of the environment upon human changes in the global climates; Environment friendly technology, Technology and development; Renewable energy and environments. Technology and environment hazards, its remedy. Major hazards of industry. The improvement of working conditions in the industry.

Recommended Texts:

1. S. Koenig, *Sociology an Introduction to the Science of Society*. Barnes & Noble, 1957
2. I. Robertson, *Society: A Brief Introduction*, 1st ed. Worth Publishers, 1988

Math 4141

Geometry and Differential Calculus

Credit: 4.00

2D Co-ordinate Geometry: Change of axes, transformation of coordinates, Simplification of equations of the curves; Pair of straight lines: Homogeneous second-degree equations, Conditions for general second-degree equations to represent a pair of straight lines, Angle between the lines, Pair of straight lines joining the origin to the points of intersection of the curve and a line; Circles and system of circles: Tangents and normal, Pair of tangents, Chord of contact, Orthogonal circles, Radical axis and its properties, Parametric coordinates.

3D Co-ordinate Geometry: Rectangular coordinates, Direction cosines and angle between two lines, The plane and the straight lines, The equation of a sphere, The standard forms of equations of the central conicoid, cones and cylinders.

Differential Calculus: Limits, 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, LaGrange's form of remainders, Cauchy's form of remainder, Expansion of functions by differentiation and integration, Partial differentiation, Euler's theorem, Tangent, maximum and minimum values of functions and points of inflection, Applications of Differential Calculus, Evaluation of indeterminate forms by L'Hospitals rule, Curvature, center of curvature and chord of curvature, Evolutes and involutes, Asymptotes, Envelopes, Curve tracing.

Recommended Texts:

1. H. Anton and A. Herr, *Multivariable calculus*, 5th ed. Wiley, 1995
2. S. L. Loney, *The Elements of Coordinate Geometry*, 11th ed. Macmillan and Company, 1908
3. E. W. Swokowski, *Calculus with Analytic Geometry*, 4th ed. Prindle, Weber & Schmidt, 1988

Phy 4141

Physics I

Credit: 3.00

Modern Physics: Michelson Morley's experiment, Galilean transformation, special theory of relativity, Lorentz transformation, relative velocity, length contraction, time dilation, mass-energy relation, Photo-electric effect, Compton effect, de-Broglie wave,

Bohr's atom model, radioactive decay, half-life, mean-life, isotopes, nuclear binding energy, alpha beta & gamma decay.

Electricity and Magnetism: Electric charge, Coulomb's law, electric field: calculation of the electric field strength, E , a dipole in an electric field, electric flux and Gauss's law, electric potential V , relation between E and V , electric potential energy; Capacitors: capacitance, dielectric in atomic view, Ampere's law, Faraday's law, Lenz's law, self-inductance and mutual inductance; Magnetic properties of matter: magnetomotive force, magnetic field intensity, permeability, susceptibility, classification of magnetic materials, magnetisation curve.

Physical Optics: Theories of light: Huygen's principle and construction; Interference of light: Young's double slit experiment, Fresnel bi-prism, Newton's rings, interferometers; Diffraction of light: Fresnel and Fraunhofer diffraction, diffraction by single slit, diffraction by double slit, diffraction gratings; Polarization: production and analysis of polarized light, optical activity.

Recommended Texts:

1. D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, 12th ed. Wiley, 2021, vol. 2
2. A. Beiser, S. Mahajan, and S. R. Choudhury, *Concepts of Modern Physics*, 7th ed. McGraw-Hill Education, 2017

CSE 4105

Computing for Engineers

Credit: 3.00

How Computer Works, Internal Components of Computer, How Programs Work, Program Design, Pseudo Code, Flow Chart, Logic Design, Program Development, Operating System Basics, Introduction to Algorithm and Data Structure, Problem Solving and Understanding.

Data Representation: Number System, Conversion of Binary, Octal, Hexadecimal to Decimal, Conversion of Binary to Octal, Hexadecimal, Conversion of Octal, Hexadecimal to Binary, Binary Arithmetic, Signed and Unsigned Numbers, Binary Data Representation, Binary Coding Schemes, Logic Gates.

Internet and the Web: Internetworking Protocol, The Internet Architecture, Managing the Internet, Connecting to Internet, Internet Connections, Internet Address, Internet Services, Uses of Internet.

Algorithms and programming: Algorithms, Efficiency, High-level languages, Compilers & Interpreters.

Role of Mathematics in Computer Science: Applications and roles of Calculus, Linear Algebra, Statistics and Probability etc. in the field of computing.

Computer Science as a Discipline: CS as science, Central themes (software, hardware, theory), subfields of CS.

Diversified applications of Computer Science and Engineering: Biology/bioinformatics, Artificial intelligence, Cryptography.

Recommended Texts:

1. A. Goel, *Computer Fundamentals*, 27th ed. Pearson, 2010
2. P. Norton, *Introduction To Computers*, 7th ed. McGraw-Hill, 2010
3. D. Reed, *A Balanced Introduction to Computer Science*, 3rd ed. Prentice Hall, 2010

CSE 4107

Structured Programming I

Credit: 3.00

Introduction to Programming Concepts, Algorithm and Logic, Constants, Variables, Keywords and Data Types, Operators and expressions, Managing Input and Output Operations, Decision Making and Branching, Decision Making and Looping, Arrays, Multi-dimensional Arrays, Strings, User defined functions, Recursion, Structures and Unions, File Management in C, Pointers, Dynamic Memory Allocation and Linked List, The Preprocessor and some advanced topics, Advanced data types and operators.

Recommended Texts:

1. H. Schildt, *Teach Yourself C*, 3rd ed. McGraw-Hill, 1997
2. E. Balagurusamy, *Programming In Ansi C*, 8th ed. Noida, Uttar Pradesh, India: McGraw Hill Education, 2019

Hum 4142

Arabic I

Credit: 1.00

Tajweed Rules of the Holy Quran; Letters and Pronunciation; Construction of words; Use of Numerical; Common Vocabularies; Name of Months, days and directions; Use of every day's conversation, dialogues and practice.

Recommended Texts:

1. M. Rashed, *Learn how to read Al-Qur'an*, <https://quranport.com/en/learn-how-to-read-quran/>, 2010

Hum 4144

English I

Credit: 1.00

This course aims to give students of an international community accurate and meaningful communicating skills which will include expressions for personal identification (name, occupation, nationality etc.); body parts; time, day, week, months and years; daily program; education and future career; entertainment; travel; postal, telephonic

and telegraphic activities; health and welfare; food and drink; adjectives and comparatives and personal and formal written needs. Grammatical structures will emphasize the various tenses, and unit, articles, prepositions and adverbial particles; adverbs of manner, frequency, time and place; punctuation; model verbs; personal pronouns; affirmative; negative and question forms; and possessives and possessive adjectives.

This course deals with the practical and communicative aspects of the English Language by reinforcing and manipulating the sounds and grammatical patterns of the language needed in an international situation through dialogues with Audio–Language, Audio–Visual, silent way and total physical response, methods and techniques involving student participation in a language laboratory with the aids of audio and video systems, computer facilities and other communicative activities.

Phy 4142

Physics I Lab

Credit: 0.75

Sessional works based on Phy 4141.

CSE 4104

Engineering Drawing Lab

Credit: 0.75

Introduction of Engineering Drawings, being familiar with the drawing instruments and their uses, drawing instruments including components and parts, drawing of geometrical figures.

Orthographic drawing, Isometric and oblique projections, First and Third angle projections, Drawing of block diagram and circuit diagram.

CSE 4108

Structured Programming I Lab

Credit: 1.50

Sessional works based on CSE 4101.

Recommended Texts:

1. Y. Kanetkar, *Let Us C: Authentic guide to C programming language*, 19th ed. BPB publications, 2022
2. B. S. Gottfried, *Schaum's Outline of Programming with C*, 2nd ed. McGraw-Hill, 1996

Second Semester

Hum 4241**Islamic History Science and Culture****Credit: 2.00**

Makki and madani lives of the Prophet Muhammad (PBUH). Caliphate of the rightly guided caliphs. Islamic Culture & Islamic festivals; Importance of acquiring knowledge of Science and Technology in the light of the Holy Quran and the Sunnah; Relation between Science & Technology and Islam; Scientific indications in the Holy Quran, Impact of Science, Technology and Religion on Society and Social Development. Contributions of Islamic Civilization and Scientific achievement on the development of modern Science and Technology.

Math 4241**Integral Calculus and Differential Equations****Credit: 4.00**

Integral Calculus: Definitions of integration, Integration by method of substitution, 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, Volume of hollow solids of revolution by shell method, Area of surface of revolution.

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 equations of second and higher orders with constant coefficients, Solution of homogeneous linear equations, Solution of differential equations of the higher order when the dependent of independent variables is absent, Solution of differential equation by the method based on the factorization of the operators, Frobenius' method, Bessel's and Legendre's differential equations and polynomials.

Partial Differential Equations: Four rules for solving simultaneous equations of the form, Lagrange's method of solving PDE of order one, Integral surfaces passing through a given curve, Nonlinear PDE of order one (complete, particular, singular and general integrals): standard forms $f(p, q) = 0$, $z = px + qy + f(p, q)$, $f(p, q, z) = 0$, $f_1(x, p) = f_2(y, q)$, Charpit's method, Second order PDE: its nomenclature and classifications to canonical (standard) - parabolic, elliptic, hyperbolic, Solution by separation of variables, Linear PDE with constant coefficients.

Recommended Texts:

1. E. W. Swokowski, *Calculus with Analytic Geometry*, 4th ed. Prindle, Weber & Schmidt, 1988
2. E. W. Swokowski, *Calculus with Analytic Geometry*, 4th ed. Prindle, Weber & Schmidt, 1988

3. Ross and L. Shepley, *Differential Equations*, 3rd ed. Wiley, 1984
4. H. T. H. Piaggio, *An Elementary Treatise on Differential Equations and Their Applications*. Forgotten Books, 2018
5. B. Epstein, *Partial Differential Equations: An Introduction*. Krieger Pub Co, 1975
6. I. N. Sneddon, *Elements of Partial Differential Equations*. Dover Publications, 2006

Phy 4241

Physics II

Credit: 3.00

Electrical Units and Standards, Electrical Networks, circuit solutions-series, series-parallel networks, loop and Nodal methods. Delta-wye Transformation, Circuit Theorems: Superposition theorem, Thevenin's and Norton's Theorem, Concept of Dual Networks.

Basic principle of generation of Alternating and Direct Current, Introduction to phasor algebra as applied to A.C. circuit analysis, Solution of A.C. circuits: Series, Parallel and Series-Parallel circuit, R.L.C circuits series and parallel resonance, Applications of Networks theorems to A.C. circuits.

The magnetic intensity, flux/density, magnetic effects of Electric current, Magnetic circuit concepts, BH curves, characteristics of magnetic materials, magnetic force and its utilization, Hysteresis and eddy current losses, magnetic circuit with A.C. and D.C. excitation.

Recommended Texts:

1. C. K. Alexander and M. N. O. Sadiku, *Fundamentals of Electric Circuits*, 6th ed. McGraw Hill, 2016
2. R. L. Boylestad, *Introductory Circuit Analysis*, 14th ed. Pearson Education India, 2022
3. R. L. Boylestad and B. A. Olivari, *Introductory Circuit Analysis*, 14th ed. Pearson, 2022

Chem 4241

Chemistry

Credit: 3.00

Atomic structure, quantum numbers, electronic configuration, and periodic table, Properties and uses of noble gases, Different types of chemical bonds and their properties, Molecular structure of compounds, Selective organic reactions, Different types of solutions and their compositions, Phase rule, phase diagram of monocomponent system, Properties of dilute solution, Thermochemistry, chemical kinetics, chemical equilibria, Ionization of water and pH concept, Electrical properties of solution.

Recommended Texts:

1. A. Bahl, B. Bahl, and G. Tuli, *Essentials of Physical Chemistry*, 1st ed. S. Chand Publishing, 2010
2. S. Z. Haider, *Introduction to Modern Inorganic Chemistry*, 3rd ed. Edexcel Publishers, 2008

CSE 4203

Discrete Mathematics

Credit: 3.00

Set theory, Elementary number theory, Graph theory, Paths and trees, Generating functions, Algebraic structures, Semigraph, Permutation groups, Binary relations, functions, Mathematical logic, Propositional calculus and predicate calculus.

Recommended Texts:

1. K. H. Rosen, *Discrete Mathematics and Its Applications*, 8th ed. McGraw-Hill Education, 2018
2. O. Nicodemi, *Discrete Mathematics*, 2nd ed. Springer, 2017
3. R. L. Graham, D. Knuth, and O. Patashnik, *Concrete Mathematics: A Foundation for Computer Science*, 2nd ed. Addison-Wesley Professional, 1994

CSE 4205

Digital Logic Design

Credit: 3.00

Number Systems and their conversion, Logic Gates, Boolean algebra, Truth Tables and K-Maps, Karnaugh map logic simplification tool, Combinational circuits analysis and design Sequential Circuit Concept: Introduction to Flip-Flops i.e. J-K F/F, Introduction to Latches, design procedures, introduction to develop state diagram and state table, Structured Sequential Circuits: Registers, shift Registers, parallel Loading of Registers, Counters: synchronous, asynchronous, serial Programmable logic: Random access memory (RAM), Programmable logic Array (PLA).

Recommended Texts:

1. M. M. Mano, C. R. Kime, and T. Martin, *Logic and Computer Design Fundamentals*, 5th ed. Pearson, 2015
2. B. Holdsworth and C. Woods, *Digital Logic Design*, 4th ed. Newnes, 2002

Hum 4242

Arabic II

Credit: 1.00

Reading Comprehension: Use of determiners and pronouns; Use of interrogatives; Use of nominal and verbal sentences Use of adverbs; Use of tenses; Use of Feminine & Masculine Genders; Conjunctive Adverbs; Nouns; Singular; Plural and various modifications caused by them; Use of verbs with different persons and all pronouns; Use of new words (nouns & verbs) by changing different parts of speech.

Hum 4244**English II****Credit: 1.00**

This course aims to develop more advanced competencies in international students of English language in reading, writing and comprehending more complex sentence structures, grammatical forms and cohesion. It will lay emphasis on awareness of better precision and fluency of structure, forms, and style. It will teach organization of paragraph, noting salient points, summarizing, writing advanced discourse, reports and stories on familiar and unfamiliar subjects. It will also teach different forms of writing letters, telegrams and applications, besides reporting speeches in indirect forms. It will involve advanced listening and speaking, role-playing, interpreting, discussing, interviewing, etc.

Phy 4242**Physics II Lab****Credit: 0.75**

Sessional works based on Phy 4241.

Chem 4242**Chemistry Lab****Credit: 0.75**

Sessional works based on Chem 4241

CSE 4202**Structured Programming II Lab****Credit: 1.50**

Experiments based on loop and conditional statement in C, Problem solving using Iterative control statement, Problem Solving with Array, multi-dimensional array and string data structure, Advance string processing tactics, Functions and Recursion, Structures and Unions, Linked List and Dynamic Memory Allocation, problem solving using pointers, File I/O in a Big Program, Standard Template Library (STL), Advanced data types and operators.

Recommended Texts:

1. E. Balagurusamy, *Programming In Ansi C*, 8th ed. Noida, Uttar Pradesh, India: McGraw Hill Education, 2019
2. H. Schildt, *Teach Yourself C*, 3rd ed. McGraw-Hill, 1997
3. Y. Kanetkar, *Let Us C: Authentic guide to C programming language*, 19th ed. BPB publications, 2022
4. B. S. Gottfried, *Schaum's Outline of Programming with C*, 2nd ed. McGraw-Hill, 1996
5. A. S. Arefin, *Art of Programming Contest*, Reprint. Gyankosh Prokashoni, 2016

CSE 4206**Digital Logic Design Lab****Credit: 0.75**

Sessional works based on CSE 4205.

Third Semester

Math 4341**Linear Algebra****Credit: 3.00**

Linear Algebra: Solving $Ax = B$ for square systems by elimination (pivots, multipliers, back substitution, invertibility of A , and factorization into $A = LU$. Complete solution to $Ax = B$ (column space containing b , rank of A , nullspace of A , and special solutions to $Ax = 0$ from row reduction).

Basis and dimension (bases for the four fundamental subspaces). Least squares solutions (closest line by understanding projections). Orthogonalization by Gram-Schmidt (factorization into $A = QR$).

Properties of determinants (leading to the cofactor formula and the sum over all $n!$ permutations, applications to inverse matrix calculation and volume). Eigenvalues and eigenvectors (diagonalizing A , computing powers A^k and matrix exponentials to solve difference and differential equations). Symmetric matrices and positive definite matrices (real eigenvalues and orthogonal eigenvectors, tests for x , $Ax > 0$, applications).

Linear transformations and change of basis (connected to the Singular Value Decomposition - orthonormal bases that diagonalize A). Linear algebra in engineering (graphs and networks, Markov matrices, Fourier matrix, Fast Fourier Transform, linear programming).

Recommended Texts:

1. G. Strang, *Introduction to Linear Algebra*, 6th ed. Wellesley-Cambridge Press, 2023
2. H. Anton, C. Rorres, and A. Kaul, *Elementary Linear Algebra: Applications Version*, 12th ed. Wiley, 2019
3. W. H. Greub, *Linear Algebra*, 4th ed. Springer, 2012

EEE 4383**Electronic Devices and Circuits****Credit: 3.00**

Semiconductors, Junction Diode and characteristics, Bipolar transistor characteristics, Small signal low frequency h parameter model, Hybrid pie model. Amplifiers, darlington pairs, introduction to oscillators, differential amplifiers, operational amplifiers, linear application of OPamp, gain, input and output impedance, offset null adjustments, frequency response and noise.

Introduction to JFET, MOSFET, PMOS, NMOS and CMOS: biasing and application in switching circuits.

SCR, TRIAC, DIAC, PJT, CRT: characteristics and applications. Introduction to rectifiers, active filters, regulated power supply, stabilizer and UPS.

CSE 4301**Object Oriented Programming****Credit: 3.00**

C++ programming: Concept of classes and objects, data and module encapsulation; polymorphism, inheritance, sub-typing, Advanced C++ I/O, virtual function; object-oriented design; generic classes, static and dynamic binding, generic classes; exception handling, Namespace and standard template library, Introduction to J++, Introduction to dot net framework.

Recommended Texts:

1. H. Schildt, *Teach Yourself C*, 3rd ed. McGraw-Hill, 1997
2. H. Schildt, *Turbo C/C++: The Complete Reference*, 2nd ed. McGraw-Hill, Inc., 1994
3. P. Deitel and H. Deitel, *C++ How to Program*, 10th ed. Pearson, 2016

CSE 4303**Data Structures****Credit: 3.00**

Introduction to data structures: what & why, Notations, Concept of efficiency. Elementary Data Structures: Arrays, Records & Pointers, Examples of Random Access, Call by Reference, Variable Length Strings, Secondary Storage and Implementation in Memory. Lists: Concept of Linked Lists. The implementation, Sub list, Recursive lists, Variants, Orthogonal lists, Stack & Queue, Sequential & circular implementation of stack & queue, Applications of stack & queue.

Graphs: Breadth-First-Search (BFS), Depth-First-Search (DFS), connected components & topological numbering, Applications.

Trees: Creation & representation, Traversal, Copying, Printing and Arithmetic interpretations of trees.

Memory Management: Uniform size records- explicit release and garbage collection.

Diverse Size Records: Allocation, Compaction.

Searching Techniques: Concept, Searching linked lists and Binary tree search.

Hashing: Extraction, Compression, Division and Multiplication, Collision Resolution: Chaining, Probing, Double hash, ordered hash, Rehash, Radix distribution.

Sorting: Discussion and comparison on different kinds of sorting (i.e. Insertion sort, Bubble sort, Quick sort, Selection sort, Merge sort etc.).

Recommended Texts:

1. E. M. Reingold and W. J. Hansen, *Data Structures*. Little, Brown, 1983
2. S. Lipschutz, *Schaum's Outline of Theory and Problems of Data Structures*. McGraw-Hill, 1986

CSE 4305	Computer Organization and Architecture	Credit: 3.00
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Components of a computer system: processors, memory, secondary storage devices and media, and other input output devices; Processor organization: registers, buses, multiplexers, decoders, ALUs, clocks, main memory and caches.

Information representation and transfer, instruction and data access methods; the control unit: hardwired and microprogrammed; memory organization, I/O systems, channels, interrupts, DMA. Von Neumann SISD organization, RISC and CISC machines.

Recommended Texts:

1. J. P. Hayes, *Computer Architecture and Organization*, 3rd ed. William C Brown Pub, 1997

CSE 4307	Database Management Systems	Credit: 3.00
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Overview of database management systems; DBMS file structures; introduction to the relational model; relational algebra, normalization and relational design; ER modeling, object-oriented modeling, advanced features of the relational model; Database Design Language; the hierarchical model; the CODASYL model; alternative data models; physical database design; fourth-generation environment; database administration, database recovery, distributed databases and current trends in the field. Relational query languages: SQL; embedded SQL in a third-generation language (COBOL, C or C++). Transaction management; concurrency control.

Recommended Texts:

1. A. Silberschatz, H. F. Korth, and S. Sudarshan, *Database System Concepts*, 7th ed. McGraw-Hill, 2019
2. C. J. Date, *An Introduction to Database Systems*, 8th ed. Pearson, 2003

3. R. Elmasri and S. Navathe, *Fundamentals of Database Systems*, 7th ed. Pearson, 2015

EEE 4384 Electronic Devices and Circuits Lab Credit: 0.75

Sessional works based on EEE 4383.

CSE 4302 Object Oriented Programming Lab Credit: 1.50

Sessional based on CSE 4301.

CSE 4304 Data Structures Lab Credit: 1.50

Sessional based on CSE 4303.

CSE 4308 Database Management Systems Lab Credit: 1.00

Sessional works based on CSE 4307.

Fourth Semester

Hum 4441 Engineering Ethics Credit: 3.00

Introduction to Engineering ethics and professionalism: What is engineering ethics? Why study engineering ethics? Responsible Professionals, Professions, and Corporations, The Origins of Ethical Thought, Ethics and the Law,

Moral Reasoning and Codes of Ethics: Ethical decision-making strategies, Ethical dilemmas, Codes of ethics, Case studies,

Moral Frameworks for Engineering Ethics: Ethical theories, Personal commitments and professional life,

Ethical Problem-Solving Techniques: Analysis of Issues in Ethical Problems, An Application of Problem-Solving Methods,

Engineering as Social Experimentation: Engineering as Experimentation, Engineers as Responsible Experimenters,

Risk, Safety, and Accidents: Assessment of safety and risk, Design considerations, uncertainty, Risk-benefit analysis, safe-exit and fail-safe systems,

Engineer's Responsibilities and Rights: Employee/employer rights and responsibilities, Confidentiality and conflict of interest, Whistle-blowing, Case studies on whistle-blowing,

Honesty and Research Integrity: Truthfulness, Trustworthiness, Research Integrity, Protecting Research Subjects,

Computer Ethics: The Internet and Free Speech, Power Relationships, Property, Privacy, Additional Issues,

Environmental Ethics: Engineering, ecology, economics, Sustainable development, Ethical frameworks

Global Issues: Multinational corporations, globalization of engineering, Technology transfer, appropriate technology,

Cautious Optimism and Moral Leadership: Cautious optimism as a technology development attitude, Moral leadership in engineering

Recommended Texts:

1. C. B. Fleddermann, *Engineering Ethics*, 4th ed. Pearson, 2011
2. W. M. Martin and R. Schinzing, *Introduction to Engineering Ethics*, 2nd ed. McGraw-Hill, 2010

Math 4441

Probability and Statistics

Credit: 3.00

Probability Law: Sets, Probabilistic Models, Conditional Probability, Independence, Total Probability Theorem, Bayes' Theorem, Counting.

Discrete Random variables: Probability Mass Functions (PMF), Cumulative Distribution Functions (CDF), Expectation, Variance; Well-known distributions (Uniform distribution, Bernoulli distribution, Binomial distribution, Poisson distribution. etc.).

Continuous Random variables: Probability Density Functions (PDF), Cumulative Distribution Functions (CDF), Expectation, Variance; Well-known distributions (Uniform distribution, Exponential distribution, Gaussian distribution).

Joint Random Variables: Joint PMFs, PDFs, Conditional Expectation, Covariance, Correlation, Independence of random Variables.

Inferential Statistics and Probability Models, Populations and Samples. Descriptive Statistics: Describing Data Sets, Summarizing Data Sets and Chebyshev's Inequality. The Sample Mean, the Central Limit Theorem, the Sample Variance, Sampling Distributions from a Normal Population. Parameter Estimation: Maximum Likelihood Estimators, Interval Estimates. Hypothesis Testing: Significance Levels, Tests Concerning the Mean of a Normal Population, Hypothesis Tests Concerning the Variance of a Normal Populations. Distribution of the Estimators.

Recommended Texts:

1. S. M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, 5th ed. Academic Press, 2014
2. R. D. Yates and D. J. Goodman, *Probability and Stochastic Processes: A Friendly Introduction for Electrical and Computer Engineers*, 3rd ed. Wiley, 2014

EEE 4483

Digital Electronics and Pulse Techniques

Credit: 3.00

Diode logic gates, Transistor switches, Transistor gates, MOS gates, Logic Families: TTL, ECL, IIL and CMOS logic with operation details, Propagation delay, Product and noise immunity, Open collector and high impedance gates, Electronic circuits for flip-flops, Counters and register, Memory systems, PLAs, A/D and D/A converters with applications, S/H circuits, LED, LCD and optically coupled oscillators, Non-linear applications of OP AMPs, Analog switches.

Linear wave shaping: Diode wave shaping techniques, Clipping and Clamping circuits, Comparator circuits, switching circuits, Pulse transformers, Pulse transmission, Pulse generation, Monostable, bistable and astable Multivibrators, Schmitt trigger, Blocking oscillators and time-base circuit, Timing circuits, Simple voltage sweeps, Linear current sweeps.

Recommended Texts:

1. H. Taub and D. L. Schilling, *Digital Integrated Electronics*. McGraw-Hill, 2008
2. M. Jacob, *Microelectronics*, 2nd ed. McGraw-Hill, 1999

CSE 4403

Algorithms

Credit: 3.00

Techniques for analysis of algorithms, Methods for the design of efficient algorithms: divide and conquer, greedy method, dynamic programming, back tracking, branch and bound, Basic search and traversal techniques, graph algorithms, Algebraic simplification and transformations, lower bound theory, NP-hard and NP-complete problems.

Recommended Texts:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, *et al.*, *Introduction to Algorithms*, 4th ed. The MIT press, 2022
2. E. Horowitz, S. Sahni, and S. Rajasekaran, *Fundamentals of Computer Algorithms*, 2nd ed. Universities Press (India) Private Limited, 2008

CSE 4405

Data and Telecommunications

Credit: 4.00

Basic concepts: Concepts and Terminology, Data representation, Data flow, Networks and network models, Protocol and standards, OSI reference model, TCP/IP protocol suite.

Data and signals: Analog and Digital data, Time and frequency domain concepts; Transmission impairment; Noisy and Noiseless channel.

Digital and Analog Transmission: Line coding scheme; Pulse code modulation; Delta Modulation; Amplitude shift keying; Frequency shift keying; Phase shift keying; Amplitude, Frequency and Phase modulation.

Multiplexing: Frequency-division multiplexing; Wavelength-division multiplexing; Time-division multiplexing, spread spectrum; Frequency hopping and Direct sequence spread spectrum.

Multiple Access Techniques: Random Access (ALOHA, CSMA, CSMA/CD, CSMA/CA), Controlled Access (Reservation, Polling, Token Passing) Channelization (FDMA, TDMA, SDMA, OFDMA, CDMA).

Transmission Media: Guided Media-Twisted pair cable; Coaxial cable; Fiber-optic cable; Unguided media- Radio wave; Microwave; Infrared and satellite communication.

Switching Network: Circuit switching network; Space and Time division switching; Control signaling; Soft switch architecture; Packet switching; Packet switching technique; Datagram and virtual circuit packet switching.

Error Detection and Correction: Types of error; Block coding; Linear block codes; Hamming code; Cyclic code Convolution codes; Trellis code.

Data link Control Protocols: Flow control; Error control; High level data link control.

Mobile communication: GSM Architecture, CDMA Architecture Cellular concept: Frequency reuse; Handoff; Channel assignment; Co-channel and adjacent channel interference; Cluster size; Cell size; Coverage; Capacity; Cell splitting, Sectoring, Power control, Frequency hopping.

Radio Propagation and channel modeling: Signal propagation mechanisms; Multipath propagation characteristics; Signal fading; Pathloss; Propagation models: Radio wave propagation modeling; Free space propagation model; Radio wave reflection: Ground reflection model; Diffractions; Scattering; Deterministic model; Outdoor propagation model: Okumura model, Hata model.

Recommended Texts:

1. B. A. Forouzan, *Data Communications and Networking*, 4th ed. McGraw-Hill, 2007

2. T. S. Rappaport, *Wireless Communication: Principles and Practice*, 2nd ed. Prentice Hall, 2002
3. Y.-B. Lin and I. Chlamtac, *Wireless and Mobile Architectures*, 1st ed. Wiley, 2000
4. V. K. Garg and J. E. Wilkes, *Principles and Applications of GSM*, T. S. Rappaport, Ed. Prentice Hall, 1999

CSE 4407

System Analysis and Design

Credit: 2.00

System concepts, System and System analysis, system planning, approach to systems development, user involvement, feasibility assessment. System investigations: objectives, methods, recording. Logic System Design, Physical Design of computer and manual sub-system, project management and documentation.

Software Project Management: life cycle, specification design, documentation, maintenance and control. Nature and sources of software tools. Program system organization, analysis of program performance, testing and verification methods, editing formatting, Microprocessing co-ordination of multiple programs.

Recommended Texts:

1. K. E. Kendall and J. E. Kendall, *System Analysis and Design*, 11th ed. Pearson, 2024
2. E. M. Awad, *System Analysis and Design*, Reprint. Galgotia Publications, 2016

EEE 4484

Digital Electronics and Pulse Techniques Lab

Credit: 0.75

Sessional based on EEE 4483.

CSE 4402

Visual Programming Lab

Credit: 1.50

Introduction of Java. Operators. Class and Method. Access Modifier. Constructor. Control Structure. Methods in Details. Enum. Variable Scope. Method Overloading. Get and Set methods. Garbage Collection. Inheritance. Polymorphism. Abstract Class and Methods. Final Methods. Interfaces. Swing Components: Jbutton, Jcombobox, Jcheckbox, Jradiobutton. Event Handling. Applets. Database Connection (Basic).

Recommended Texts:

1. P. Deitel and H. M. Deitel, *Java: How to Program*, 9th ed. Pearson College Div, 2011

CSE 4404

Algorithms Lab

Credit: 1.00

Sessional works based on CSE 4403.

CSE 4408

System Analysis and Design Lab

Credit: 1.00

Sessional works based on CSE 4407.

Fifth Semester

CSE 4501

Operating Systems

Credit: 3.00

Types of operating systems: single user, real-time, batch, multiple access. Principles of operating systems; design objectives; sequential processes; concurrent processes, concurrency, functional mutual exclusion, processor co-operation and deadlocks, processor management. Control and scheduling of large information processing systems. Resource allocation, dispatching, processor access methods, job control languages. Memory management, memory addressing, paging and store multiplexing. Multiprocessing and time sharing, batch processing. Scheduling algorithms, file systems, protection and security; design and implementation methodology, performance evaluations and case studies.

Recommended Texts:

1. A. Silberschatz, P.B. Galvin, and G. Gagne, *Operating System Concepts*, 10th ed. Wiley, 2018
2. A. S. Tanenbaum, *Modern Operating Systems*, 5th ed. Pearson Education, Inc., 2022

CSE 4503

Microprocessor and Assembly Language

Credit: 3.00

Microprocessor and Assembly Language: Microprocessors and Microcomputers, Evaluation of Microprocessors Applications, Intel 8086 Microprocessor: internal architecture, register structure, programming model, addressing modes, instruction set, Assembly language programming, Coprocessors. An overview of Intel 80186, 80286, 80386, 80486 and Pentium microprocessors, RISC processors.

Recommended Texts:

1. V. Hall and S. S. P Rao, *Microprocessors and Its Interfacing*, 3rd ed. McGraw Hill, 2017
2. Y. Y. Ytha and C. Marut, *Assembly Language Programming and Organization of the IBM PC*, 1st ed. McGraw-Hill/Irwin, 1992

3. R. S. Gaonkar, *Microprocessor Architecture, Programming, and Applications with the 8085*, 6th ed. Penram International Publishing, 2013
4. B. B. Brey, *The Intel Microprocessors*, 8th ed. Pearson, 2013

CSE 4511

Computer Networks

Credit: 3.00

Introduction to computer networks, Uses of computer networks, Network models, Network topology, Layered approach of networking protocols, Design issues of layers, and TCP/IP protocol suite.

Data link layer: Design issues; error control, detection and correction; Logical link control sub-layer, Medium access sub-layer; Multiple access protocols, Medium access mechanisms - ALOHA, slotted ALOHA, CSMA, CSMA/CD, CSMA/CA, WDMA; Medium access protocols - IEEE 802.3: Ethernet, IEEE 802.4: Token bus, IEEE 802.5: Token ring, Introduction to WiFi; High speed LANs, FDDI, Fast Ethernet, and Gigabit Ethernet; LAN extension - Bridges, Switches, and VPN.

Network layer: IP addressing, IP packet forwarding, Subnetting, CIDR, Internet protocol, ICMP, ARP, RARP, DHCP, and IPv6 overview; Routing protocols.

Transport layer: Functionalities; User datagram protocol (UDP) - UDP operations and UDP package modules, Transmission control protocol (TCP) - TCP features, TCP Connection establishment and termination, TCP Flow control and error control, Congestion control.

Application layer: DNS, Electronic mail (SMTP, POP, IMAP), FTP, WWW.

Recommended Texts:

1. B. A. Forouzan, *Data Communications and Networking*, 4th ed. McGraw-Hill, 2007
2. L. L. Peterson and B. S. Davie, *Computer Networks: A Systems Approach*, 6th ed. Morgan Kaufmann, 2021
3. A. S. Tanenbaum, *Computer Networks*, 6th ed. Pearson, 2020

CSE 4513

Software Engineering and Object-Oriented Design

Credit: 3.00

Software Engineering principles, Life cycle models, Sizing, Estimation, Planning and control, Requirements Specification, Functional specification and design. Integration and testing strategies, Quality assurance, Configuration management, Software maintenance, Management of programming teams, programming methodologies, Debugging aids, Documentation and measurement of software verification and testing techniques and the problems of maintenance, Modification and portability.

Object oriented concepts, Abstraction and modeling; Object modeling - Identification, Classification, Association, Generalization and Aggregation, Inheritance, Meta-data and Notation for object modeling; Use case, dynamic modeling - State transition diagrams and object life cycles; State chart, class diagram, Design pattern, Object oriented development methodologies - Object modeling technique, Object oriented analysis, Object oriented design; Object communication models; and Integration of models.

Recommended Texts:

1. R. S. Pressman and B. R. Maxim, *Software Engineering: A Practitioner's Approach*, 9th ed. McGraw Hill, 2019
2. J. R. Rumbaugh, M. R. Blaha, W. Lorensen, *et al.*, *Object-Oriented Modeling and Design*, 1st ed. Prentice-Hall, 1991
3. G. Booch, J. R. Rumbaugh, and I. Jacobson, *The Unified Modeling Language User Guide*, 2nd ed. Addison-Wesley Professional, 2005
4. C. Larman, *Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development*, 3rd ed. Pearson, 2004
5. S. Bennett and R. Farmer, *Object-Oriented Systems Analysis and Design Using UML*, 4th ed. McGraw-Hill, 2010
6. E. Gamma, R. Helm, R. Johnson, *et al.*, *Design Patterns: Elements of Reusable Object-Oriented Software*, 1st ed. Addison-Wesley Professional, 1994

CSE 4502

Operating Systems Lab

Credit: 1.00

Sessional works based on CSE 4501.

CSE 4504

Microprocessor and Assembly Language Lab

Credit: 0.75

Sessional works based on CSE 4503.

CSE 4508

RDBMS Programming Lab

Credit: 1.50

Relational Database Programming: Introduction. Its role in S/W development. Relational Database Basic Constructs: Table, Keys, Views, Cardinality. Introduction to SQL. Relational query and sub-query. Redundancy and Functional composition in Database. Concept of Joins: Natural joins.

View: its usage and restrictions. Introduction to PL/SQL. PL/SQL Control Structures. Functions and Procedures. Introduction to Cursor. Records. Transaction Management. Oracle Collection. Large Objects. PL/SQL Package. Database Triggers.

Dynamic SQL. Introduction to Database Administration. Database Performance Tuning. Brief Introduction to other Relational Databases such as: MySQL, PostGRE, MS SQL Server.

Recommended Texts:

1. M. McLaughlin, *Oracle Database 11g PL/SQL Programming*, 1st ed. McGraw-Hill Education, 2008

CSE 4510

Software Development

Credit: 0.75

Over the last five years or so, the software industry has begun to explore lightweight development methodologies as alternative approaches for building software. These so-called "agile" methodologies emphasize the value of people - programmers and clients - over rigid processes. In this course, several of these agile methodologies will be studied and evaluated. Real programming projects will be implemented. An important part of trying them out will be to use some of the of the interesting new tools that support agile methods, such as: unit testing frameworks, such as JUnit refactoring browsers, such as Eclipse and IntelliJ's IDEA build management tools such as Ant and Maven.

Recommended Texts:

1. D. Thomas and A. Hunt, *The Pragmatic Programmer: Your Journey To Mastery*, 2nd ed. Addison-Wesley Professional, 2019
2. K. Beck and C. Andres, *Extreme Programming Explained: Embrace Change*, 2nd ed. Addison Wesley, 2004
3. R. C. Martin, *Agile Software Development: Principles, Patterns, and Practices*, 1st ed. Pearson Higher Education, 2013

CSE 4512

Computer Networks Lab

Credit: 1.50

Sessional works based on CSE 4511.

Elective 5-I

Math 4541

Multivariable Calculus and Complex Variables

Credit: 3.00

Complex Variable: Review of analytic functions and Cauchy-Riemann equations, Paths in the complex plane, parameterization, contours, Contour integrals, re-parameterization, Cauchy's theorem, Cauchy integral formula, Liouville's theorem and

fundamental theorem of algebra, Laurent and Taylor series, Singularities, residues and the residue theorem, Evaluation of real integrals.

Multivariable calculus: Vectors in the plane, Vectors in three dimensions, Dot products, Cross products, Lines and curves in space, Calculus of vector-valued functions, Motion in space, Length of curves, Curvature and normal vectors.

Plane and surfaces, Graph and level curves, Limits and continuity, Partial derivatives, The chain rule, Directional derivatives and the gradient, Tangent planes and linear approximation, Maximum/minimum problems, Lagrange multipliers.

Double integrals over rectangular regions, Double integrals over general regions, Double integrals over Polar Regions, Triple integrals, Triple integrals in cylindrical and spherical coordinates, Integrals for mass calculations, Change of variables in multiple integral.

Recommended Texts:

1. J. W. Brown and R. V. Churchill, *Complex Variables and Applications*, 9th ed. McGraw-Hill, 2013
2. J. Hass, C. Heil, and M. Weir, *Thomas' Calculus: Multivariable*, 14th ed. Pearson, 2017

CSE 4531

E-Commerce and Web Security

Credit: 3.00

E-commerce Business Models and Concepts: Identify the key components of e-commerce business models, B2C business models, major B2B business models, Recognize business models in other emerging areas of e-commerce, key business concepts and strategies applicable to e-commerce.

The Internet and World Wide Web: E-commerce Infrastructure: The origins of the Internet, Key technology concepts behind the Internet, Role of Internet protocols and utility programs, Current structure of the Internet, How the World Wide Web works, How Internet and Web features and services support e-commerce.

E-commerce Marketing concept: Identify the key features of the Internet audience, Basic concepts of consumer behavior and purchasing decisions, understanding how consumers behave online, Basic marketing concepts needed to understand Internet marketing, Main technologies that support online marketing.

Ethical, Social, and Political Issues in E-commerce: Main ethical, social, and political issues raised by e-commerce, A process for analyzing ethical dilemmas, Basic concepts related to privacy, Practices of e-commerce companies that threaten privacy, Different methods used to protect online privacy, Major public safety and welfare issues raised by e-commerce.

Online Security and Payment Systems: Scope of e-commerce crime and security problems, Key dimensions of e-commerce security, Key security threats in the e-commerce

environment, how technology helps protect the security of messages sent over the Internet, Tools used to establish secure Internet communications channels, and protect networks, servers, and clients, Features of traditional payment systems, The major e-commerce payment mechanisms.

Recommended Texts:

1. C. L. Kenneth and G. T. Carol, *E-commerce 2023: business. technology. society*, 17th ed. Pearson Education, 2023
2. J. Andress and S. Winterfeld, *Cyber Warfare: Techniques, Tactics and Tools for Security Practitioners*, 2nd ed. Syngress, 2013

CSE 4537

Decision Support Systems

Credit: 3.00

An introduction to computer-based decision support. The nature of management, theories of decision making, approaches to decision support, decision support technologies, the development of decision support systems, executive information systems, and group decision support systems. Assessment will include the development of a small decision support system using common spreadsheet software to illustrate the concepts presented in lectures. Students will be expected to spend a significant amount of personal study time early in the semester learning the software and developing skills in representing decision situations.

Recommended Texts:

1. D. R. Arnott and P. A. O'Donnell, Eds., *Readings in Decision Support Systems*, 2nd ed. Department of Information Systems, Monash University, 1994

CSE 4547

Parallel and Distributed Systems

Credit: 3.00

Parallel processing: Importance, architecture, hardware and software issues, Architecture for parallel processing, classification, comparative study of different architecture, hardware issues of parallel processing

Distributed processing: Definition, impact of distributed processing on organizations, pitfalls in distributed processing.

Forms of distributed processing: Function distribution, Hierarchical distributed systems, Horizontal distributed systems, strategies of distributed data processing, control of complexity, problem of incompatibility, centralisation vs. Decentralisation, design of distributed data, location of data, multiple copies of data, conflict analysis.

Multiprocessing Control and Algorithm, Multiple Architecture and Processing, Data flow Computation and VLSI Computation.

Recommended Texts:

1. K. Hwang and F. A. Briggs, *Computer Architecture and Parallel Processing*, 1st ed. McGraw-Hill, 1986

Elective 5-II

CSE 4539

Web Programming

Credit: 3.00

Introduction: The Internet model, Web browsers, Useful tools, Layers of the Internet World Wide Web, Domain Name Service, Uniform Resource Locator, Overview of Web Applications.

Web programming using HTML and xHTML: History of Markup Language, HTML Basics, Tags, Formatting Text, Creating Links, Adding Images, Lists, Tables, Frames, Forms, Cascading Style Sheets (CSS), Graphics.

Javascript: Introduction to javascript, Javascript syntax, Variables, Simple functions.

PHP: Generating HTML Dynamically, Processing Forms, Maintaining State in Web Applications, Cookies, Data Tier, Back-end Database Support, SQL Primer, Database Interface in PHP, Searching in Web Applications, Regular Expressions and Matching, Multimedia and Interactivity, Audio on the Web, Video on the Web.

Advanced tools: AJAX, Flash, Flex.

Recommended Texts:

1. J. N. Robbins, *Learning Web Design: A Beginner's Guide to HTML, CSS, JavaScript, and Web Graphics*, 5th ed. O'Reilly Media, 2010
2. L. Welling and L. Thomson, *PHP and MySQL Web Development*, 5th ed. Addison-Wesley Professional, 2016
3. E. Brown, *Learning JavaScript: JavaScript Essentials for Modern Application Development*, 3rd ed. O'Reilly Media, 2016
4. M. Gibbs and D. Wahlin, *Professional ASP.NET 2.0 AJAX*, 1st ed. Wrox Pr Inc, 2007
5. B. Brinzarea, C. Darie, and A. Hendrix, *AJAX and PHP: Building Modern Web Applications*, 2nd ed. Packt Pub Ltd, 2009

CSE 4543

Geographical Information Systems

Credit: 3.00

The subject aims to introduce students to the key basic principles and techniques used in the development of geographical information systems. It has a particularly strong focus on the application of GIS in practice and the evolution of approaches

to their development and use. The main topics addressed include introduction to GIS concepts, basic hardware, software and data requirements for GIS development, evolution of GIS technology, key areas of application of GIS in practice, issues in the management of GIS, the organizational role of GIS, and emerging trends in GIS development and usage.

CSE 4549

Simulation and Modeling

Credit: 3.00

Introduction and basic simulation procedures. Model classification like Monte Carlo simulation, discrete-event simulation, continuous system simulation, mixed continuous/ discrete-event simulation, Simulation Languages, random number generation and testing, analysis of simulation results, confidence intervals, variance reduction techniques. Case studies of analytical and simulation studies of computer systems.

Analytical versus simulation modeling, Workload modeling, Random variables. Commonly used distributions. Stochastic processes, Markov chain models of computer systems, steady-state and transient analyses, queuing models, Single server and multi-server queues, open and closed queuing networks. model verification and validation, Petri nets, state charts, hybrid models, system dynamics and object-oriented modeling. Simulation and modeling in life.

Input and output analysis: random numbers, generating and analyzing random numbers, sample generation, trace- and execution-driven simulation, point and interval estimation. Process-oriented and parallel and component simulation and modeling

Performance evaluation methods, Performance measurement and benchmarking, workload characterization, the representation of measurement data, instrumentation: software monitors, hardware monitors, capacity planning, bottleneck detection, system and program tuning, simulation and analytical models and their application, case studies.

Recommended Texts:

1. R. Jain, *The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling*, 1st ed. Wiley, 1991
2. K. S. Trivedi, *Probability and Statistics with Reliability, Queueing and Computer Science Applications*, 2nd ed. Wiley, 2016
3. A. M. Law, *Simulation Modeling and Analysis*, 6th ed. McGraw-Hill, 2024

CSE 4551

Computer Graphics and Multimedia Systems

Credit: 3.00

Introduction to computer graphics: brief history, applications, hardware and software and the fundamental ideas behind modern computer graphics.

Two-dimensional graphics: device-independent programming; graphics primitives and attributes.

Interactive graphics: physical input devices, event-driven input; user interface. Transformations; translation, rotation, scaling, shear.

Three-dimensional graphics: 3D curves and surfaces; projections.

Multimedia System Architecture. Objects for Multimedia System: Text; Images and graphics: Basic concepts, Computer image processing; Sound/ Audio: Basic concepts, Music, MIDI, Speech; Video and animation: Basic concepts, Computer-based animation.

Data Compression Techniques: JPEG; H.261 (px64); MPEG; Intel's DVI; Microsoft AVI; Audio compression; Fractal compression.

Multimedia File Standards: RTF; TIFF; RIFF; MIDI; JPEG DIB; AVI Indeo; MPEG.

Multimedia Storage and Retrieval Technology: Magnetic media technology; Optical media technology: Basic technology, CD Digital audio, CD-ROM, its architecture and further development, CD-Write only (CD-WO), CD- Magnetic optical (CD-MO).

Architecture and Multimedia Communication Systems: Pen input; Video and image display systems; Specialized processors: DSP; Memory systems; Multimedia board solutions; Multimedia communication system; Multimedia database system (MDBMS).

User Interfaces: General design; Video and Audio at the user interface.

Multimedia Applications: Imaging; Image/Voice processing and recognition; Optical character recognition; Communication: Tele-service, Messaging; Entertainment: Virtual reality, Interactive audio and video, Games.

Recommended Texts:

1. J. D. Foley, A. Van Dam, S. K. Feiner, *et al.*, *Introduction to Computer Graphics*, 2nd ed. Addison-Wesley Reading, 1994
2. E. Angel, *Interactive Computer Graphics: A Top-Down Approach with Shader-Based OpenGL*, 6th ed. Pearson, 2011
3. D. Hearn, P. Baker, and W. Carithers, *Computer Graphics with OpenGL*, 4th ed. Pearson, 2010
4. R. Steinmetz and K. Nahrstedt, *Multimedia Systems*. Springer, 2004. DOI: 10.1007/978-3-662-08878-4
5. R. Steinmetz and K. Nahrstedt, *Multimedia: Computing, Communications and Applications*, 6th ed. Pearson, 2009
6. P.K. Andleigh and K. Thakrar, *Multimedia Systems Design*, 1st ed. Pearson India, 2015

CSE 4540

Web Programming Lab

Credit: 0.75

Sessional based on CSE 4539.

CSE 4544

Geographical Information Systems Lab

Credit: 0.75

Sessional works based on CSE 4543.

CSE 4550

Simulation and Modeling Lab

Credit: 0.75

Sessional works based on CSE 4549.

CSE 4552

**Computer Graphics and Multimedia Systems
Lab**

Credit: 0.75

Sessional works based on CSE 4551.

Sixth Semester

Hum 4641

Accounting

Credit: 3.00

Define Accounting and Book-keeping. Distinguish between Accounting and Book-keeping. Users of Accounting information. Transactions processing, Journalizing, Accounts, Classification. What are the books of accounts generally prepared by medium and small enterprises. Subdivision of journal. Posting entries into ledger, preparation of ledger accounts. Preparation of ledger accounts. Preparation of sales and purchase day books, sales return and purchase return books, cash books and journal proper. Capital Expenditure and Revenue Expenditure, Capital Receipts and Revenue Receipts. Preparation of Final Accounts including (Manufacturing Accounts) Trading, Profit and Loss Accounts and Balance Sheets and Interpretation and analysis of Balance sheet & income Statement of accounting information in project formulation and appraisal. Cost accounting and elements of cost, preparation of cost sheet showing cost of production, Budget and budgetary control; cost- volume-profit-analysis (Break-even-analysis and Break-even point).

Recommended Texts:

1. J. J. Weygandt, P. D. Kimmel, and D. E. Kieso, *Accounting Principles*, 12th ed. Wiley, 2015
2. S. P. Basu and M. Das, *Practice in Accountancy*, 9th ed. Amit Biswas Publication, 2002

CSE 4615**Wireless Networks****Credit: 2.00**

Introduction to wireless networks: wireless access networks - wireless mesh networks, personal area networks (wireless sensor networks, body area networks, Low-Pan, 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, AirTime Metric, routing protocols - AODV, DSR, DSDV, HWMP, sensor network routing, VANET routing etc.

Wireless Transport protocols; Wireless TCP and its variants, Hop by Hop Congestion Control, Rate based Congestion Control etc. Quality of Service in Wireless Networks.

Recommended Texts:

1. W. Stallings, *Wireless Communications and Networks*, 2nd ed. Pearson, 2005
2. B. H. Walke, S. Mangold, and L. Berlemann, *IEEE 802 Wireless Systems: Protocols, Multi-Hop Mesh/Relaying, Performance and Spectrum Coexistence*, 1st ed. Wiley, 2007

CSE 4619**Peripherals and Interfacing****Credit: 3.00**

Interrupts, address space partitioning, A-to-D and D-to-A converters and some related chips. Interfacing ICs of I/O devices - I/O ports, Programmable peripheral interface, DMA controller, interrupt controller, communication interface, interval time, etc. IEEE 488 and other buses, interfacing with microcomputer. Interfacing I/O devices - floppy disk, hard disk, tape, CD-ROM & other optical memory, keyboard, mouse, monitor, plotter, scanner, etc. Microprocessor in Scientific Instruments and other applications - Display, Protective Relays, Measurements of Electrical quantities, Temperature monitoring system, water level indicator, motor speed controller, Traffic light controller, etc. Microprocessor based interface design.

Recommended Texts:

1. R. T. Ilarionov, *Computer Peripherals*, 2nd ed. Vasil Aprilov Gabrovo, 2013
2. P. Marwedel, *Embedded System Design: Foundations of Cyber-Physical Systems, and the Internet of Things*, 4th ed., N. D. Dutt and G. Martin, Eds. Springer, 2021
3. A. S. Berger, *Embedded System Design: An Introduction to Processes, Tools and Techniques*, 1st ed. CMP Books, 2001

Introduction: Defining machine learning, Scalability, Privacy issues and social impact, Applications in AI, Computer vision, Computer games, Search engines, Marketing, Bioinformatics, Robotics, HCI and Graphics.

Graphical models: Introduction to discrete probability, Inference in Bayesian networks, Maximum likelihood and Bayesian learning Model selection.

Supervised learning: Introduction to continuous probability, Linear regression and classification (least squares and ridge), Model assessment and cross-validation, Introduction to optimization, Nonlinear regression (neural nets and Gaussian processes), Boosting and feature selection.

Unsupervised learning: Nearest neighbors and K-means, Spectral kernel methods for clustering and semi-supervised learning. The EM algorithm, Mixture models for discrete and continuous data, Temporal methods: hidden Markov models & Kalman filters, Boltzmann machines and random fields, Examples: web mining, collaborative filtering, music and image clustering, automatic translation, spam filtering, computer games and object recognition.

Neural Network: Fundamentals of Neural Networks, Back-propagation and related training algorithms, Hebbian learning, Cohen-Grossberg learning, The BAM and the Hopfield Memory, Simulated Annealing, Different type of Neural Networks: Counter-propagation, Probabilistic, Radial Basis Function, Generalized Regression, etc., Adaptive Resonance Theory, Dynamic Systems and Neural Control, The Boltzmann Machine, Self-organizing maps, Spatiotemporal Pattern Classification, The Neocognition, Practical aspects of Neural Networks.

Other forms of learning: Semi-supervised learning, Active learning, Reinforcement learning, Self-taught learning, Evolutionary learning: Genetic algorithm, Genetic programming, CGA.

Recommended Texts:

1. C. M. Bishop, *Pattern Recognition and Machine Learning*, 1st ed. Springer, 2006
2. R. S. Sutton and A. G. Barto, *Reinforcement Learning: An Introduction*, 2nd ed. The MIT Press, 2018
3. T. M. Mitchell, *Machine Learning*, 1st ed. McGraw-hill Education, 1997
4. R. O. Duda, P. E. Hart, and D. G. Stork, *Pattern Classification*, 2nd ed. Wiley, 2000
5. T. Hastie, R. Tibshirani, and J. Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, 2nd ed. Springer, 2009
6. D. J. C. MacKay, *Information Theory, Inference and Learning Algorithms*, 1st ed. Cambridge University Press, 2003

7. E. Alpaydin, *Introduction to Machine Learning*, 4th ed. The MIT Press, 2020

CSE 4610	Design Project	Credit: 1.50
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Students will develop some projects based on previously acquired subject knowledge.

CSE 4614	Technical Report Writing	Credit: 0.75
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Issues of technical writing and effective oral presentation in Computer Science and Engineering; Writing styles of definitions, propositions, theorems and proofs; Preparation of reports, research papers, theses and books: abstract, preface, contents, bibliography and index; Writing of book reviews and referee reports; Writing tools: L^A-TEX; Diagram drawing software; presentation tools; Definition of plagiarism; Types of plagiarism; How to detect plagiarism; Plagiarism and world wide web; How to avoid plagiarism.

Recommended Texts:

1. B. Eunson, *Writing and Presenting Reports*, 1st ed. Wiley, 1994
2. R. P. Clark, *Writing Tools: 55 Essential Strategies for Every Writer*, 1st ed. Little, Brown Spark, 2008
3. H. Hering, *How to Write Technical and Scientific Reports: Understandable Structure, Good Design, Convincing Presentation*, 3rd ed. Springer, 2025
4. L. Lamport, *LaTeX: A Document Preparation System*, 2nd ed. Addison-Wesley Professional, 1994

CSE 4616	Wireless Networks Lab	Credit: 0.75
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Sessional works based on CSE 4615.

CSE 4620	Peripherals and Interfacing Lab	Credit: 0.75
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Sessional works based on CSE 4619.

CSE 4622	Machine Learning Lab	Credit: 0.75
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Sessional works based on CSE 4621.

Elective 6-I

Math 4641

Numerical Methods

Credit: 3.00

Solution of algebraic and Transcendental equation: Iterative method, Gauss elimination method, Gauss-Seidel method and their applications in Engineering fields.

Interpolation/Extrapolation: Interpolation with one and two independent variables. Formation of different difference table. Newton's forward and backward difference, Lagrange's interpolation, Neville-Aitken's interpolation, Successive iteration.

Numerical Integration: Trapezoidal rule, Gauss's Quadratic formula, Multiple integration, Romberg's method, Truncation and error estimation. Numerical solution of differential equations, Numerical solution of partial differential equations, curve fitting, Methods of least square, Estimation of linear and nonlinear parameters, formulation, different engineering experimental results.

Recommended Texts:

1. J. D. Faires and R. L. Burden, *Numerical Methods*, 4th ed. Cengage Learning, 2012
2. M. A. Celia and W. G. Gray, *Numerical Methods for Differential Equations: Fundamental Concepts for Scientific and Engineering Applications*, 1st ed. Pearson College Div, 1991
3. L. W. Johnson and R. D. Riess, *Numerical Analysis*, 2nd ed. Addison-Wesley Publishing Company, 1982

CSE 4641

Distributed Operating Systems

Credit: 3.00

Introduction to Distributed Systems Communication in Distributed Systems. Synchronization in Distributed Systems: Clock Synchronization, Mutual Exclusion, Election Algorithms, Atomic Transactions, Deadlocks in Distributed Systems. Processes and Processors in Distributed Systems: Threads, System Models, Processor Allocation, Scheduling in Distributed Systems, Fault tolerance, Real-Time Distributed Systems. Distributed File Systems: Distributed File System Design, Distributed File System Implementation, Trends in Distributed File Systems. Distributed Shared Memory: Consistency Model, Page-Based Distributed Shared Memory, Shared-Variable Distributed Shared Memory, Object-Based Distributed Shared Memory, Comparison. Case Study: Amoeba, Mach, Chorus.

Recommended Texts:

1. A. S. Tanenbaum, *Distributed Operating Systems*, 1st ed. Dorling Kinderslayu Pvt Ltd., 2009

CSE 4643

Mobile Application Development

Credit: 3.00

Basic concepts: Mobile computing; Mobile computing architecture, Mobile technologies, Anatomy of a mobile device, Applications of mobile computing, Technical issues for mobility, Mobile agents and process migration.

Introduction to Mobile Development Frameworks and Tools: Fully Centralized Frameworks and Tools, N-Tier Client-Server Frameworks and Tools, J2ME, WAP, Symbian EPOC, iPhone, Android, Windows CE.

Android application development: Getting started with android programming, Android architecture, Application framework and libraries, Android runtime, Linux kernel, Android user interface, Data persistence, Messaging and networking, Location Based Services, Developing android services, Android application publishing.

The User Experience: The Small Screen Problem, The Unified Look and Feel Paradigm, The iPhone Human Interface Guidelines, The Blackberry User Interface Guidelines, Common User Interface Guidelines,

Security Issues in mobile computing: Security threats, Ensuring consistency and reliability.

The Future of Mobile Computing: Upcoming Technologies, Convergence of Media and Communication Devices.

Recommended Texts:

1. R. B'Far, *Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML*, 2nd ed. Cambridge University Press, 2004
2. K. Garg, *Mobile Computing: Theory and Practice*, 1st ed. Pearson Education, 2010
3. W.-M. Lee, *Beginning Android Application Development*, 1st ed. Wrox Press, 2011
4. R. Rogers, J. Lombardo, Z. Mednieks, et al., *Android Application Development: Programming with the Google SDK*, 1st ed. Shroff, 2009
5. D. Wolber, H. Abelson, E. Spertus, et al., *App Inventor 2: Create Your Own Android Apps*, 2nd ed. O'Reilly, 2014
6. S. Li and J. Knudsen, *Beginning J2ME: From Novice to Professional*, 3rd ed. Apress, 2005
7. T. Mikkonen, *Programming Mobile Devices: An Introduction for Practitioners*, 1st ed. Wiley, 2007

CSE 4647**Distributed Database Systems****Credit: 3.00**

Introduction to Distributed Database Systems. Database System Architecture: Centralized System, Client-Server Systems, Parallel Systems, Distributed Systems, Network Types, Distributed Data Storage, Network Transparency, Data Query Processing, Data Transaction Model, Commit protocols, Coordinator Selection, Concurrency Control, Deadlock Handle, Multi Database system, Design of Distributed Database, Location of Database, Multiple copies of Data, Distributed Database and Applications.

Math 4642**Numerical Methods Lab****Credit: 0.75**

Sessional works based on Math 4641.

CSE 4642**Distributed Operating Systems Lab****Credit: 0.75**

Sessional works based on CSE 4641.

CSE 4644**Mobile Application Development Lab****Credit: 0.75**

Sessional works based on CSE 4643.

CSE 4648**Distributed Database Systems Lab****Credit: 0.75**

Sessional works based on CSE 4647.

Elective 6-II

CSE 4631**Digital Signal Processing****Credit: 3.00**

Classification of signals and systems, signal representation, discrete and analog signals.

Z-transform: Z-transformation, Inverse Z-transformation, Theorems and proposition, system functions.

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

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 digital signal processing (DSP): Image processing, Radar systems, Telecommunications etc.

Recommended Texts:

1. J. G. Proakis and D. K. Manolakis, *Digital Signal Processing: Principles, Algorithms and Applications*, 5th ed. Pearson, 2021

CSE 4635

Web Architecture

Credit: 3.00

The objective of this course is to introduce and explain the basic concepts of web architecture. Students of this course assume to have prior knowledge of computer network and programming languages as the prerequisite. A reasonable familiarity of java programming will be the added advantage. Throughout the course, the introductory concepts of web architectures for developing web applications will be studied. Students will learn how to write Java applications that share data across the Internet for games, collaboration, software updates, file transfer and more. A behind-the-scenes look at HTTP, CGI, Servlets, Enterprise Java Beans, ORM, which supports the Internet and the Web will be provided. This course explores the knowledge and the tools to create the next generation software that takes full advantage of the Internet.

Recommended Texts:

1. C. Andres and S. Herr, *Great Web Architecture*, 1st ed. Wiley, 1999
2. L. Shklar and R. Rosen, *Web Application Architecture: Principles, Protocols and Practices*, 2nd ed. Wiley, 2009

CSE 4649

Systems Programming

Credit: 3.00

Concepts of system programming, assembler, compiler, loader, technical design of assembler and compiler, CPU instruction set, OS architecture, device drivers, virus and anti-virus, working principle of virus and anti-virus.

Basic concepts of security, security models. Threats to security: areas of vulnerability, physical security, data security, system security, computer system security, communication security, and personal security.

Threat Perpetration: sources, manmade, accidental, thread perpetration measures, identity verification.

Risk assessment workshop and case study, disaster recovery and contingency plan, security management, future of computer security.

Recommended Texts:

1. L. L. Beck, *System Software: An Introduction to Systems Programming*, 3rd ed. Pearson, 1996

CSE 4651**Unix Programming****Credit: 3.00**

Introduction to UNIX, History, Layering, OSI Model, UNIX Model.

C Programming tools in UNIX, The C Language, single and multi-module programme, UNIX file dependency system, UNIX Archive System, UNIX Source Code Control System, UNIX profiler, Unix Debugging, System Programming

Inter process Communication, Communication Protocols, TCP/IP, XNS, SNA, Net-BIOS and OSI Protocols, UUCP, Berkley Sockets, Unix Domain Protocols, Socket Addresses, elementary and advanced socket UNIX Shells, Shell functionality, systems call, System versus Transport Layer Interface, Transport Endpoint addresses, elementary a and advanced TLI functions, I/O Multiplexing, Library Routines, time and Date Routines, Ping Routines.

Recommended Texts:

1. G. Glass and K. Ables, *UNIX for Programmers and Users*, 3rd ed. Pearson, 2003
2. W. R. Stevens, *UNIX Network Programming*. Pearson, 1990
3. M. Gandhi, R. Shah, T. Shety, *et al.*, *The 'C' Odyssey: UNIX — The Open Boundless C*, 3rd ed. BPB Publications, 2013

CSE 4632**Digital Signal Processing Lab****Credit: 0.75**

Sessional works based on CSE 4631.

CSE 4636**Web Architecture Lab****Credit: 0.75**

Sessional works based on CSE 4635.

CSE 4650**Systems Programming Lab****Credit: 0.75**

Sessional works based on CSE 4649.

CSE 4652**Unix Programming Lab****Credit: 0.75**

Sessional works based on CSE 4651.

Seventh Semester

Hum 4741

Business Communication and Law

Credit: 2.00

Communicating in today's workplace, the writing process, communicating at work, Reporting workplace data, Professionalism, Teamwork, Meeting and speaking skill.

Principles of law of contracts; Company law: law regarding formation, incorporation, management and winding up of companies; Labor law: law in relation to wages hours, health, safety and other condition to work; The trade union legislation arbitration, the policy of the state in relation to labor; The Factory Act (1965); The Law of compensation.

Analytical mode of cyber law in security and society, Cyber law hypothesis, Cyber-crime, security in cyber society sector research analysis, security in cyber society cyber law in security, General law & Cyber law, Cyber security and benefits.

Recommended Texts:

1. J. Dwyer and N. Hopwood, *The Business Communication Handbook*, 11th ed. Cengage Learning, 2019
2. M. E. Guffey and D. Loewy, *Essentials of Business Communication*, 12th ed. Cengage Learning, 2022
3. A. P. Kumar, *Cyber Law*, 1st ed. CreateSpace Independent Publishing Platform, 2009

Hum 4743

Engineering Economics

Credit: 2.00

Definition of Economics, Economics and Engineering, Principles of Economics, Micro-Economics and Macro-Economics.

Micro-Economics: Introduction to various economic systems - Capitalist, Command and Mixed Economy, Fundamental Economic problems and their solutions, Theory of demand, supply and their elasticities, Consumer behavior theory, Utility analysis approaches - cardinal and ordinal approaches, Price determination, Nature of an economic theory, Applicability of economic theories to the problems of developing countries, Indifference curve techniques, Theory of production, Production function, Types of productivity, Rational region of production of an engineering firm, Concepts of market and market structure, Cost analysis and cost function, Small scale production and large scale production, Optimization, Theory of Distribution, Use of derivative in Economics, Maximizing and minimizing economic functions, Relationship among total, marginal and average concepts.

Macro-Economics: Savings, Investment, Employment, National income analysis, Inflation, Monetary Policy, Fiscal policy, Trade policy, Economics of development and

planning, Partial equilibrium theory, Representation and Solution theory, Applications in Bangladesh.

Recommended Texts:

1. S. H. Aby, J. Nalen, and L. Fielding, *Sociology: A Guide to Reference and Information Sources*, 3rd ed. Libraries Unlimited, 2005
2. S. W. Bowmaker, *The Art and Practice of Economics Research: Lessons from Leading Minds*. Edward Elgar Publishing, 2013

Hum 4745

International Relationship

Credit: 2.00

An introduction to contemporary analysis of international relations. Students will learn major theories of international relations and apply them to understand international situations and issues in the modern world. Emphases are on clearly comprehending the relationship between international conflicts and cooperation and on recognizing the shift from “internationalization” to “globalization”. Extensive use of internet information, articles from professional journals and newspapers will enable students to update information about imminent international issues today and to think about them critically.

Recommended Texts:

1. J. Baylis, S. Smith, and P. Owens, *The Globalization of World Politics: An Introduction to International Relations*, 9th ed. Oxford University Press, 2023
2. K. A. Mingst and H. E. McKibben, *Essentials of International Relations*, 9th ed. WW Norton & Co, 2021
3. H. R. Nau, *Perspectives on International Relations: Power, Institutions, and Ideas*, 7th ed. CQ Press, 2020

Math 4741

Mathematical Analysis

Credit: 3.00

Review of Probability, Random variables; Stochastic processes, Markov chains and simple queuing theory. Applications to program and algorithms analysis; Computer systems performance and reliability modeling; Renewal Theory, Distribution of $N(t)$, Limit theorems and their applications, Renewal reward process, Semi-Markov process; Techniques and models to develop and demonstrate wide range of problems associated with the design and analysis of various probabilistic systems in Computer Science.

Recommended Texts:

1. R. Jain, *The Art of Computer Systems Performance Analysis: Techniques for Experimental Design, Measurement, Simulation, and Modeling*, 1st ed. Wiley, 1991

2. S. M. Ross, *Introduction to Probability and Statistics for Engineers and Scientists*, 5th ed. Academic Press, 2014
3. P. V. Miegheem, *Performance Analysis of Communications Networks and Systems*, 1st ed. Cambridge University Press, 2009

CSE 4703

Theory of Computing

Credit: 3.00

Formal methods of automata language and computability, Finite automata and regular expressions, Properties of regular sets, Context-free grammars, Push-down automata, Properties of context-free languages, Turing machines, Halting problem, Undecidability and Computability, Recursion function theory, Chomsky hierarchy, Deterministic context-free languages, Closure properties of families of languages, Computational complexity theory, Intractable problems, Applications in parsing, pattern matching and the design of efficient algorithms.

Finite state machines, Introduction to sequential circuits, basic definition of finite state model, memory elements and their excitation functions, synthesis of synchronous sequential circuits, iterative networks, definition and realization of Moore and Mealey machines.

Recommended Texts:

1. M. Sipser, *Introduction to the Theory of Computation*, 3rd ed. Cengage Learning, 2012
2. J. E. Hopcroft, R. Motwani, and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, 3rd ed. Pearson, 2006
3. J. Adamek and V. Trnkova, *Automata and Algebras in Categories*. Springer, 1990

CSE 4711

Artificial Intelligence

Credit: 3.00

Survey of concepts in artificial intelligence. Knowledge representation, search and control techniques. All machines and features of the LISP and PROLOG languages. Problem representation: search, inference and learning in intelligent systems; systems for general problems solving, game playing, expert consultation, concept formation and natural language procession: recognition, understanding and translation. Case Study on Expert Systems.

Recommended Texts:

1. S. J. Russell and P. Norvig, *Artificial Intelligence: A Modern Approach*, 4th ed. Pearson, 2021

Sessional works based on CSE 4711.

CSE 4790**Industrial Training****Credit: 1.00**

The students will participate in an Industrial training for a period of 4 weeks. The Industrial training will start after the final examination of sixth semester and will end before the start of the seventh semester.

Elective 7-I

CSE 4739**Data Mining****Credit: 3.00**

Introduction and Background: Different types of data and patterns, technologies used. Data Objects and Attribute Types. Basic Statistical Descriptions used in Data-Mining. Data Preprocessing: An Overview. Data Cleaning. Data Integration. Data Reduction. Data Transformation and Data Discretization. Data Warehouse: Basic Concepts. Data Warehouse Modeling: Data Cube and OLAP. Data Warehouse Design and Usage. Data Cube Technology: Concepts. Data Cube Computation Methods. Processing Advanced Kinds of Queries by Exploring Cube Technology. Mining Frequent Patterns, Associations, and Correlations. Classification: Basic Concepts. Decision Tree Induction. Bayes Classification Methods. Rule-Based Classification. Model Evaluation and Selection. Techniques to Improve Classification Accuracy. Cluster Analysis: Basic Concepts and Methods. Partitioning Methods. Hierarchical Methods. Density-Based Methods.

Recommended Texts:

1. J. Han, J. Pei, and H. Tong, *Data Mining: Concepts and Techniques*, 4th ed. Morgan Kaufmann, 2022

CSE 4743**Cryptography and Network Security****Credit: 3.00**

Fundamentals: OSI security architecture, Security goals, Types of attacks, Cryptography and Cryptanalysis basics, Steganography, Classical encryption techniques, Cipher principles

Private/Shared/Symmetric Key Cryptography: Data encryption standard (DES), Block cipher design principles and modes of operation, Evaluation criteria for AES, AES ci-

pher, Triple DES, Placement of encryption function, Traffic confidentiality, Key Management, Key distribution center (KDC)

Public/Assymmetric Key Cryptography: Key management, Diffie Hellman key exchange, Elliptic curve architecture and cryptography, Introduction to number theory, Confidentiality using symmetric encryption, Public key cryptography and RSA, Public Key Infrastructure (PKI), PKI Trust Models, Certificate standard (PKIX and X.509), Certificate authority (CA), Certificate revocation.

Authentication and Hash Function: User authentication/Authentication of people, UNIX password system, Mutual Authentication, Authentication protocols Mediated Authentication (with KDC), Many to many authentication, Kerberos Authentication requirements, Authentication functions, Message authentication codes, Hash functions, Security of hash functions and MACS, MD5 Message Digest algorithm, Secure hash algorithm (SHA), HMAC digital signatures, Digital signature standard,

Network Security: Network layer security, IP security (IPSec), Transport Layer Security TLS/SSL, Electronic mail security, PGP S/MIME, Web security, VPN and Multimedia security (SRTP and MIKey)

System Level Security: Intrusion detection, Password management, Viruses and related threats, Virus counter measures, Firewall design principles, Trusted systems.

Recommended Texts:

1. D. R. Stinson and M. Paterson, *Cryptography: Theory and Practice*, 4th ed. CRC Press, 2018
2. W. Stallings, *Cryptography and Network Security: Principles and Practice*, 7th ed. Pearson, 2016
3. B. A. Forouzan, *Cryptography & Network Security*, 2nd ed. McGraw-Hill, Inc., 2011
4. C. Kaufman, R. Perlman, M. Speciner, *et al.*, *Network Security: Private Communication in a Public World*, 3rd ed. Addison-Wesley Professional, 2022

CSE 4745

Embedded Systems Design

Credit: 3.00

Introduction to Embedded system, The Embedded Design Life Cycle, Models of Computation, State Charts, General language Characteristics (SDL, Petri nets, Message Sequence Charts, UML, JAVA, HDL), Embedded System Hardware, (Input, Communication, Processing Unit, Memories, output) Embedded operating systems, middle-ware & Scheduling, Implementing, ASIC, Embedded Systems Hardware/Software codesign.

Recommended Texts:

1. A. S. Berger, *Embedded System Design: An Introduction to Processes, Tools and Techniques*, 1st ed. CMP Books, 2001

CSE 4747

Computational Biology

Credit: 3.00

Genomics, Bioinformatics & Molecular Biology, Systematic Literature Search, Human Genome Project, Genome and Sequence Databases, Protein Sequence and Motif Databases, Sequence Alignment, Sequence Similarity Search, Multiple Sequence Alignment, Distance based Phylogenies, Building Protein Motifs and Models, Ab initio Protein Structure Prediction, Clustering Coordinately Regulated Genes, Discovering Gene Regulatory Signals, Gene Regulatory Modules and Networks, MicroRNA Regulatory Networks, Simple Nucleotide Polymorphisms (SNPs), Genome Variations, Genome-Wide Association Studies, Metabolic Pathways and Analyses I, Metabolic Pathways and Analyses II.

Elective 7-II

CSE 4733

Digital Image Processing

Credit: 3.00

Introduction to Signal Processing, Pattern Processing, Computer Graphics, Artificial Intelligence, Human Visual System, Digital Image Representation: Acquisition, Storage & Display, Sampling and Quantization, Uniform and Non-uniform Sampling Image Geometry: Perspective Transformation, Synthetic Camera Approach, Stereo Imaging, Image Transform: FFT, PFT, Sine Transformation, Cosine Transformation, Image Enhancement: Spatial and Frequency Domain, Smoothing and Sharpening, Edge Detection, Histogram: Grey Level, Binary Image, Thresh Holding, Half-toning, Image Segmentation: Mathematical Morphology, Dilation and Erosion, Opening and Closing, Image Restoration: Gradation Model, Constrain and Unconstraint Restoration, Inverse Filtering, Wiener's Filtering, Image Compression: Source Coding-decoding, Channel Coding-decoding, Practical Image Processing: Electronic Formation of Images, Speed / Memory Problem, Architectures, Decompositions and Algorithms, Computer Implementations for Image Processing Task.

Recommended Texts:

1. R. C. Gonzalez and R. E. Woods, *Digital Image Processing*, 4th ed. Pearson, 2017
2. M. Sonka, V. Hlavac, and R. Boyle, *Image Processing, Analysis, and Machine Vision*, 4th ed. Cengage Learning, 2014
3. T. Morris, *Computer Vision and Image Processing*, 1st ed. Red Globe Press, 2003

CSE 4735

Digital Systems Design

Credit: 3.00

Designing I/O system; I/O devices; Designing Microprocessor based system with interfacing chips; Programmable peripheral interface (interface to A/D and D/A converter); Keyboard/display interface;

Programmable timer; Programmable interrupt controller, DMA controller;

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.

Recommended Texts:

1. I. Grout, *Digital Systems Design with FPGAs and CPLDs*, 1st ed. Newnes, 2008
2. A. P. Godse and D. A. Godse, *Digital System Design*, 1st ed. Technical Publications, 2019

CSE 4749

Introduction to Cloud Computing

Credit: 3.00

Fundamentals of cloud computing: Types of cloud computing, enabling technologies-virtualization, Web services, SOA, Web 2.0, cloud computing features, cloud computing platforms; Comparable technologies: Grid Computing, Utility Computing, The role of grid computing in cloud computing, difference between cloud and utility computing. Cloud architecture: Cloud scheduling, Scalability, reliability and security of the cloud, Workflow management in cloud, Network infrastructure for cloud computing, Virtualization technologies and its security related issues; Cloud service Models: Software as a Service (SaaS), Platform as a Service (PaaS), google AppEngine, Microsoft Azure etc, Infrastructure as a Service (IaaS), Openstack, EC2 etc, Data as a Service (DaaS); Cloud computing applications: Virtual private cloud, Scientific services and data management in cloud, Enterprise cloud, Medical information systems; Big Data Introduction: Variety of Data, Velocity of Data, Veracity of Data, Distributed file system such as Hadoop, Data centric computing such as map-reduce, Distributed database; Cloud business models.

Recommended Texts:

1. B. Furht and A. Escalante, *Handbook of Cloud Computing*, 1st ed. Springer, 2010
2. P. Zikopoulos, D. deRoos, K. Parasuraman, et al., *Harness the Power of Big Data The IBM Big Data Platform*, 1st ed. McGraw-Hill, 2012
3. K. Hwang, J. Dongarra, and G. C. Fox, *Distributed and Cloud Computing: From Parallel Processing to the Internet of Things*, 1st ed. Morgan Kaufmann, 2012
4. R. Buyya, J. Broberg, and A. M. Goscinski, *Cloud computing: Principles and paradigms*, 1st ed. Wiley, 2011

Basic Networking Software (Protocol stacks, TCP/IP, HTTP, etc) Internet architecture and history, Elementary socket programming in C, Low level networking, Ethernet, ARP, The network layer, IP, DHCP, NAT, The network layer, routing, IPv6, Transport layer protocols, TCP, UDP, The socket interface (writing clients and servers) Advanced socket programming, non-blocking sockets, Server design (forking, threads, pre-forking), daemons, Network Programming in Java, DNS, email, HTTP, cgi, cookies, P2P Web services (XML, JSP, SOAP, etc) XML, DTDs, Schemas, XML Parsing, XSLT, Client side scripting, Javascript, AJAX, Web server technologies, Tomcat, servlets, Web server technologies, JSP, Web server, technologies, RPCs, Java RMI, XML-RPC, CORBA, Server scripting languages, PHP, Ruby Web services, SOAP, WSDL, UDDI, The Semantic Web, RDF, OWL; Network security Cryptography, authentication, digital signatures, Network security, Kerberos, IPSec, SSL, Implementation of security, Anonymity on the Web, tor, Multimedia and VoIP, RTP

Recommended Texts:

1. W. R. Stevens, *UNIX Network Programming*. Pearson, 1990
2. T. Chan, *UNIX System Programming Using C++*, 1st ed. Prentice Hall, 2011
3. J. B. Maurice, *The Design of the UNIX Operating System*, 1st ed. Pearson, 1986

Introduction of bioinformatics, Biological analysis, Software development and use of bioinformatics, Data models and web resources; Tools for informatics, Biological databases and databanks and data mining; Applications for Bioinformatics, Biostatistics, Various biological databases, Bio tools and computer techniques.

Recommended Texts:

1. N. C. Jones and P. A. Pevzner, *An Introduction to Bioinformatics Algorithms*, 1st ed. The MIT press, 2004
2. J.-M. Claverie and C. Notredame, *Bioinformatics For Dummies*, 2nd ed. Wiley, 2006
3. D. W. Mount, *Bioinformatics: Sequence and Genome Analysis*, 2nd ed. Cold Spring Harbor Laboratory Press, 2004
4. W. J. Ewens and G. R. Grant, *Statistical Methods in Bioinformatics: An Introduction*, 2nd ed. Springer, 2005
5. P. Jambeck and C. Gibas, *Developing Bioinformatics Computer Skills: An Introduction to Software Tools for Biological Applications*, 1st ed. O'Reilly Media, Inc., 2001

CSE 4734	Digital Image Processing Lab	Credit: 0.75
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Sessional works based on CSE 4733.

CSE 4736	Digital Systems Design Lab	Credit: 0.75
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Sessional works based on CSE 4735.

CSE 4750	Introduction to Cloud Computing Lab	Credit: 0.75
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Sessional works based on CSE 4749.

CSE 4752	Network Programming Lab	Credit: 0.75
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Sessional works based on CSE 4751.

CSE 4754	Bioinformatics Lab	Credit: 0.75
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Sessional Works based on CSE 4753.

Eighth Semester

CSE 4801	Compiler Design	Credit: 3.00
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Introduction to compiler concepts; Compiling techniques including parsing, semantic processing, and optimization; Compiler-compilers and translator writing systems; Scope rules, block structure, and symbol tables; Runtime stack management and run time support; Parameter passing mechanisms; Stack storage organization and templates; Heap storage management; Intermediate code; Code generation Macros; Error management; A small project.

Recommended Texts:

1. A. Aho, J. Ullman, R. Sethi, *et al.*, *Compilers: Principles, Techniques, and Tools*, 2nd ed. Addison Wesley, 2006
2. A. I. Holub, *Compiler Design in C*, 1st ed. Prentice-Hall, 1990
3. J.-P. Tremblay and P. G. Sorensen, *The Theory and Practice of Compiler Writing*, 1st ed. McGraw-Hill, 1985

Structure and Basic Definition of Graph Theory, methodology, proofs, basic properties of graphs, graph operations and their symbolic designation. Orientation of graphs, associated matrices and their relationship. Groups, automorphism graphs, symmetric graphs, graph enumeration, graph coloring, five color problem, four color conjecture, Heawood map coloring theorem, critical graphs, homomorphism.

Graph algorithms, ordered tree, Huffman tree, catalan numbers, maxflow problem and solutions, maximum matching in bipartite graph, zero-one net flow, NP-complete problems, Euler and Hamilton path and circuit.

Recommended Texts:

1. N. Deo, *Graph Theory with Applications to Engineering and Computer Science*, 1st ed. Dover Publications, 2016

Management Fundamentals: Managers &, Management, Managing in today's world.

Planning: Foundation of planning and decision making.

Organizing: Basic organization, staffing & human resource management, managing change & innovation.

Leading: Foundations of individual & group behavior, undertaking work teams, motivating & rewarding employees, leadership & trust, communication & inter-personnel skills.

Controlling: Foundation of Control, Technology & Operations.

IT industry Scenario: Study on various types of IT organizations - Software development, Software Testing, Network, ISP, Web development, etc. IT status in various countries, Organisation of an Information Service Centre, organogram, infrastructure, external communication, administration & management scenario of an IT organization. IT Project Management.

Recommended Texts:

1. S. P Robbins, M. Coulter, and D. A. DeCenzo, *Fundamentals of Management: Essential Concepts and Applications*, 10th ed. Pearson, 2016
2. D. Billows, *Managing Information Technology Projects*, 1st ed. The Hampton Group, Inc., 2000
3. D. Billows, *Essential of Project Management*, 11th ed. The Hampton Group, Inc., 2011
4. P Chandra, *Project, Planning, Analysis, Financing, Implementation and Review*, 8th ed. McGraw Hill, 2017

5. C. Sivakumar and K. S. Babai, *Management of Information Services*. McGraw Hill, 2023

CSE 4809

Algorithm Engineering

Credit: 2.00

Introduction and review of asymptotic analysis including big-oh notation, divide and conquer algorithms and its application in sorting, matrix multiplication etc., Median finding and selection, interval scheduling, the substitution method, the master method.

Introduction and applications of probability and randomized algorithms, quicksort and its analysis, radix sort, sorting lower bound, hashing, open addressing and amortization, amortized analysis.

The greedy algorithm design paradigms and its applications, dynamic programming design paradigm and its applications.

Graph primitives, BFS, DFS, topological sort in DAGS, all pairs shortest paths, minimum spanning trees and their applications to clustering, heaps and their applications.

Competitive analysis, network flow i.e. max flow and min cut algorithms, interlude: problem solving, van Emde Boas data structure.

Intractable problems and what to do about them, NP-completeness and the P vs. NP question, polynomial time approximations, sublinear-time algorithms, heuristics with provable performance guarantees, Approximation Algorithms, Fast Fourier Transform, local search, Linear Programming, exponential-time algorithms that beat brute-force search.

Recommended Texts:

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, *et al.*, *Introduction to Algorithms*, 4th ed. The MIT press, 2022
2. A. Levitin, *Introduction to the Design and Analysis of Algorithms*, 3rd ed. Pearson, 2011
3. J. J. McConnell, *Analysis of Algorithms: An Active Learning Approach*, 2nd ed. Jones & Bartlett, 2008

CSE 4802

Compiler Design Lab

Credit: 0.75

Sessional works based on CSE 4801.

Sessional works based on CSE 4809.

Elective 8-I

CSE 4841**Introduction to Optimization****Credit: 3.00**

Introduction of the principal algorithms for linear, network, discrete, nonlinear, dynamic optimization and optimal control especially their methodology and the underlying mathematical structures. The simplex method, network flow methods, branch and bound and cutting plane methods for discrete optimization, optimality conditions for nonlinear optimization, interior point methods for convex optimization, Newton's method, heuristic methods, and dynamic programming and optimal control methods.

Recommended Texts:

1. E. K. P. Chong, W.-S. Lu, and S. H. Zak, *An Introduction to Optimization: With Applications to Machine Learning*, 5th ed. Wiley, 2023
2. G. Hadley, *Linear Programming*. Narosa Book Distributors Private Ltd, 2002
3. M. S. Bazaraa, J. J. Jarvis, and H. D. Sherali, *Linear programming and network flows*, 4th ed. Wiley, 2009

CSE 4845**Introduction to Information Retrieval****Credit: 3.00**

Introduction: basic structure and major topics of this course, and go over some logistic issues and course requirements

Search engine architecture: basic building blocks of a modern search engine system, including web crawler, basic text analysis techniques, inverted index, query processing, search result interface.

Retrieval models: Retrieval model, a.k.a., ranking algorithm, is arguably the most important component of a retrieval system, and it directly determines search effectiveness. We will discuss classical retrieval models, including Boolean, vector space, probabilistic and language models. We will also introduce the most recent development of learning-based ranking algorithms, i.e., learning-to-rank.

Retrieval evaluation: Assessing the quality of deployed system is essential for retrieval system development. Many different measures for evaluating the perfor-

mance of information retrieval systems have been proposed. We will discuss both the classical evaluation metrics, e.g., Mean Average Precision, and modern advance, e.g., interleaving.

Relevance feedback: User feedback is important for retrieval systems to evaluate the performance and improve the effectiveness of their service strategies. However, in most practical system, only implicit feedback can be collected from users, e.g., clicks, which are known to be noisy and biased. We will discuss how to properly model implicit user feedback, and enhance retrieval performance via such feedback.

Link analysis: We will discuss the unique characteristic of web: inter-connection, and introduce Google's winning algorithm PageRank. We will also introduce the application of link analysis techniques in a similar domain: social network analysis.

Search applications: We will introduce modern applications in search systems, including recommendation, personalization, and online advertising, if time allows.

Recommended Texts:

1. C. D. Manning, P. Raghavan, and H. Schuetze, *Introduction to Information Retrieval*, 1st ed. Cambridge University Press, 2008
2. W. B. Croft, D. Metzler, and T. Strohman, *Search Engines: Information Retrieval in Practice*, 1st ed. Pearson, 2009
3. R. Baeza-Yates and B. Ribeiro-Neto, *Modern Information Retrieval*, 2nd ed. Wesley, 2011

CSE 4847

Information and OS Security

Credit: 3.00

An overview of information security: confidentiality, integrity, and availability Understanding the Threats; Malicious software (Viruses, trojans, rootkits, worms, botnets) Memory exploits (buffer overflow, heap overflow, integer overflow, format string); Formalisms Access control theory, access control matrix Information flow; Policy, Security policies, Confidentiality policies (BLP model), Integrity policies (Biba, and Clark-Wilson model), Hybrid policies (Chinese Wall model, role-based access control), Operating system security, Introduction to operating system security, Understanding the Threats such as Viruses and Worms, Logging, Auditing, and Recovery, OS-level Memory Protection, Virtualization Technology and Applications, Vulnerability Analysis, Malware Capture and Analysis (Honeypots and Honeyfarm), Rootkits.

Recommended Texts:

1. M. Palmer, *Guide to Operating Systems Security*, 1st ed. Cengage Learning, 2003
2. M. Bishop, *Computer Security: Art and Science*, 2nd ed. Addison-Wesley Professional, 2018

Foundations, The Human: Input-output channels, Human memory, thinking: Reasoning and problem solving, individual Differences, Psychology and the Design of interactive Systems.

The Computer: Text Entry Devices, Output Devices, Memory, Paper: Printing and scanning, processes.

The Interaction: Models of Interaction, Frameworks and HCI, Ergonomics, Interaction styles, The context of the Interaction.

Design Practice: Paradigms for interaction, Principles to support Usability, Using Design Rules, Usability Engineering, Interactive Design and Prototyping, Modules of the user in Design: Cognitive Models, Goal and Task Hierarchies, Linguistic Models. The challenges of Display Based Systems, cognitive Architectures; Task Analysis: Task Decomposition, Knowledge Based Analysis, E-R Based Techniques, Sources Information and Data Collection, Uses of Task Analysis. Dialogues Notations and Design: Dialogue Notations, Textual Dialogue Notations, Dialogue Semantics, Dialogue Analysis and Design; Models of the System: Standard Formalisms, Interaction Models, Status/Event Analysis; Implementation Support; Evaluation Technique; Help and Documentation: Requirements of user support, Approaches to user support, Intelligent help Systems.

Groupware: Groupware systems, Meeting and Decision support systems, Framework for Groupware. CSCW Issues and Theory: Face to Face Communication, conversation. Multi-sensory Systems: Usable sensory Inputs, speech in the interface, Handwriting Recognition; Text Hypertext and Hypermedia; Gesture Recognition, Computer Vision, Application of Multimedia Systems.

Recommended Texts:

1. A. Dix, J. E. Finlay, G. D. Abowd, *et al.*, *Human-Computer Interaction*, 3rd ed. Pearson, 2003

This course is an introduction to software design patterns. Each pattern represents a best practice solution to a software problem in a specific context. The course covers the rationale and benefits of object-oriented software design patterns. Numerous problems will be studied to investigate the implementation of good design patterns.

Topics: Strategy, Observer, Factory, Singleton, Command, Adapter, Facade, Template Method, Iterator, Composite, State, Proxy.

Recommended Texts:

1. E. Freeman and E. Robson, *Head First Design Patterns: Building Extensible and Maintainable Object-Oriented Software*, 2nd ed. O'Reilly Media, 2021

Elective 8-II

CSE 4833

VLSI Design and Testing

Credit: 3.00

Introduction to basic VLSI design, Design of microelectronic circuits such as registers, technology trends and design automation algorithms, Introduction to CMOS, inverters and basic gates, Brief overview of CMOS fabrication process, layout and design rules, CMOS subsystem, adder and related functions, multipliers, programmable logic arrays via large scale integrated circuitry with emphasis on high-level structured design methods for VLSI systems Hardware modeling: Introduction to HDL, hardware modeling languages, Structural Specification of Hardware, logic networks, state diagrams, data flow and sequencing graphs, behavioral optimization.

Architectural synthesis: Circuit specification, strategies for architectural optimization, data path synthesis, control unit synthesis, synthesis of pipelined circuits.

Testing techniques and algorithms, Various methodologies for testing.

Utilities for High Level Descriptions. Dataflow Descriptions in HDL, HDL Systems, CPU Modeling and Design. Interface Modeling and Design.

Recommended Texts:

1. Z. Navabi, *VHDL: Modular Design and Synthesis of Cores and Systems*, 3rd ed. McGraw Hill, 2007
2. D. L. Perry, *VHDL: Programming By Example*, 4th ed. McGraw-Hill Professional, 2002

CSE 4835

Pattern Recognition

Credit: 3.00

Introduction to Pattern Recognition, classification, description. Patterns and Feature extraction. PR approaches, Training and Learning in PR, Common Recognition Problems.

Statistical PR, The gaussian case and class dependence, Discriminant Function, classifier performance, Risk and Errors, Supervised Learning, Parametric Estimation and Supervised learning, Maximum likely hood estimation, The Bayesian Parameter Estimation Approach. Supervised Learning Using Non-Parametric Approaches, Parzen windows.

Linear Discriminant Function and the Discrete and Binary Feature cases, Unsupervised Learning and clustering, Syntactic Pattern Recognition (SPR), Syntactic Pattern Recognition via parsing and other grammars, Graphical approaches to Syntactic Pattern Recognition, Graph based structural presentation, graph Isomorphism, similarity measurements, Learning via grammatical Inference.

Introduction to Neural Recognition and Neural Pattern associators and Matrix approaches.

Recommended Texts:

1. R. O. Duda, P. E. Hart, and D. G. Stork, *Pattern Classification*, 2nd ed. Wiley, 2000
2. R. J. Schalkoff, *Pattern Recognition: Statistical, Structural And Neural Approaches*, 1st ed. Wiley, 2007

CSE 4839

Internetworking Protocols

Credit: 3.00

Introduction to wireless networks, wireless media, overview of Internet technology, Internet services, electronic mail, UseNet, SNMP, SMTP, URL, URI, HTTP, MIME and WWW.

Multi access protocols; Aloha, CSMA and its variations, token ring; error control techniques, flow and congestion control, window and rate-based schemes, TCP ATM, ABR, hop-by-hop schemes, quality of service: in ATM, IETF integrated services model, differentiated services model, mobile IP, data link layer protocols; routing algorithms and protocols, multicast: IGMP, PIM, DVMRP, spanning tree protocol.

Overview of IEEE 802.11(e/g/h/ac): standard for Wireless Local Area Networks (WLANs), IEEE 802.15: standard for Wireless Personal Area Networks (WPANs), IEEE 802.15.1: standard for Bluetooth, IEEE 802.15.4: standard for ZigBee, IEEE 802.15.5: standard for Mesh Network, IEEE 802.16: standard for Wireless Metropolitan Area Networks (WMANs), IEEE 802.15.5: standard for Mobile Broadband Wireless Access, wireless ATM networks, voice over IP (VoIP), Mobile IP, Internet using mobile phones, roaming algorithms, handover techniques, satellite communications.

Recommended Texts:

1. A. S. Tanenbaum, *Computer Networks*, 6th ed. Pearson, 2020
2. W. Stallings, *Data and Computer Communications*, 10th ed. Pearson, 2013
3. F. Halsall, *Data Communications, Computer Networks, and Open Systems*, 4th ed. Wesley, 1996
4. C. Huitema, *Routing in the Internet*. Prentice-Hall, 1999
5. K. R. Fall and W. R. Stevens, *TCP/IP Illustrated*, 2nd ed. Addison-Wesley Professional, 2011, vol. I, II, III
6. D. E. Comer, *Internetworking with TCP/IP: Principles Protocols, and Architecture*, 6th ed. Pearson, 2013
7. J. F. Kurose and K. W. Ross, *Computer Networking*, 8th ed. Pearson, 2020

CSE 4834	VLSI Design and Testing Lab	Credit: 0.75
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Sessional works based on CSE 4833.

CSE 4836	Pattern Recognition Lab	Credit: 0.75
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Sessional works based on CSE 4835.

CSE 4840	Internetworking Protocols Lab	Credit: 0.75
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Sessional works based on CSE 4839.