DEPARTMENT OF

COMPUTER SCIENCE

BS(HONS.)
COMPUTER SCIENCE

STUDENTS HANDBOOK

(SESSION 21-25)

GC UNIVERSITY LAHORE

DEPARTMENT OF COMPUTER SCIENCE

http://www.dcs.gcu.edu.pk

First printing, July 2015

Table of Contents

Contents

1. The Vice-Chancellor's Message

My Dear Students

I am pleased that you have joined Government College University Lahore, one of the most prestigious academic institutes of our country! I congratulate you on your achievements at the start of undergraduate studies which you attained after the hardwork in your earlier studies, and obvious also an outcome of your success from tough and multi-stages of the new admission processes. As you know that GC University Lahore has produced a number of nationally and internationally renowned intellectuals, scholars, scientists, poets, statesmen, and players you know amongst them Allama Dr. Muhammad Iqbal, Dr. Abdus Salam, Dr. Mahboob ul Haq, and now you have become the part of an historic continuum of the Alma-Mater of these great personalities. The GC University is unique in its culture which gives specific emphasis on personal development along with academic uplift through number of societies and modern academic programs. Recently, GC University introduced number of new academic programs to encompass the eager academic needs of the society.

The education in general develops personalities for positive contribution in society and consequently in nation, but the higher education has become the knowledge economy whereas its multidimensional adaptability in different areas from agricultural engineering to space technology provides confidence and strength to an individual and the nation at large. The current era is an era of Computer Science and Information Technology, where its application is everywhere from mobile to medical sciences. The concept of global village has become reality only through the utilization of Information Technology. It has also tremendous contribution in the global economy. The Department of Computer Science though new as compared to about century old departments like Physics, Chemistry, History, and Zoology but it is undoubtedly one of the most important departments of GC University. It is the biggest department of the University in terms of number of students, and it runs BS, MS and PhD programs. You are amongst the lucky students who have got admission

in the Department of Computer Science through your successful achievement out of more than 7000 applicants with this great honor you also have a great responsibility on your shoulders. Our Faculty is here to ensure that you are given every opportunity to learn and to succeed academically. Our staff will support your needs and the administration invites you to join them in partnership with much that needs to be done in this exceptional year of GCU Lahore.

Warm regards

PROF. DR. ASGHAR ZAIDI (T.I.)
VICE CHANCELLOR

PREFACE

The curriculum with varying meanings as specified in Wikipedia in education, a curriculum (plural curricula or curriculums) is broadly defined as the totality of student experiences that occur in the educational process. The term often refers specifically to a planned sequence of instruction, or to a view of the student's experiences in terms of the educator's or school's instructional goals. Therefore, curriculum is an accepted standardized sequence of planned experiences where learner practice and achieve proficiency in content and to apply the learning skills. Curriculum is the core guide for all educators as to what is essential for teaching and learning, so that every student has access to rigorous academic experiences.

The Department of Computer Science GC University Lahore designed the BS(Hons) in Computer Science curriculum keeping in view the guidelines of the Higher Education Commission (HEC) Islamabad's curricula for BS/MS Computer Science and International trends in Computer Science and Information Technology needs world wide. It has been finalized by the experienced faculty of the Department after series of meetings and discussions. The curriculum or any new course or amended course requires lot of approvals before its actual adoption. This includes approval from Departmental Academic Committee, Board of Studies, the University Academic Council, and the Syndicate. The curriculum has been segregated as per requirements of HEC that includes computing core courses, computer science core, elective, and supportive courses, university elective, mathematical foundation courses, and general education courses spread over 4 years each year comprising of 2 semesters. The curriculum of Computer Science provides the details of various courses offered at BS(Hons) level which includes the details of more than 70 courses with their pre-requisites.

PROF. DR. SYED ASAD RAZA KAZMI
CHAIRPERSON
DEPARTMENT OF COMPUTER SCIENCE

2. GC University Lahore

2.1 Introduction

Government College Lahore began its journey on January 1, 1864, with a class consisting of nine students. It was twelve years later with 115 pupils, a staff of able scholars, painstaking tutors and prescient educationist having a vibrant vision for the future, that GC was shifted to its present location in Anarkali Lahore. After 138 years of meritorious evolution and achievement, Government College, Lahore was raised to the status of a University in 2002. It was renamed as Government College (GC) University Lahore. This Institution takes pride in being the oldest educational institution of higher learning in Pakistan, having presently 10,726 students and 367 teaching faculty. It is a centre of academic excellence and intellectual development in the country. Graduates from the University continue to be leaders in all walks of life, steered by three basic guiding principles: efficiency, relevance and quality. We shall continue to produce graduates who are equipped to contribute to the intellectual, social, political, moral and material development of the societies in which they are to live; and to recognize that the development of contemporary societies reflects diversity alongside consensus and acknowledgement of the past as well as concern for innovation.

You will find GCU an inviting place to pursue your academic goals while practicing personal, recreational and scenic exploration. The academic programmes at the University aimed at imparting interdisciplinary knowledge, a broader vision and a critical awareness of current issues. Students at GCU discover new insights and employ logical approaches to solve problems. GC University Lahore has attained a distinguished place among Pakistani Universities due to its strong commitment to teaching and research pursuits. Committed to specialized and discipline education, at the Undergraduate level, the University offers BA/BSc 4-Year (Hons.) Degree Programme in 26 disciplines of Science & Technology, Arts and Social Sciences and Languages. At the Postgraduate level, the University offers MA/MSc, MBA and EMBA, M.Phil/MS and PhD Degrees in various disciplines of Science & Technology, Arts & Social Sciences and Languages in a highly research-conducive environment.

All departments are well equipped with the necessary resources required for research work. Computer labs., Internet facility, multimedia, overhead projectors, a massive collection of books, journals, professional periodicals, digital library, research labs and seminar rooms are available to our scholars.

The University is a liberal, co-educational institution, providing a congenial atmosphere to students to study and conduct research in areas of their choice. The University believes in undertaking research, consultancy and other forms of services to local and regional communities which will enrich our teaching and advance our quest for wisdom and truth.

GCU has long established traditions of consistent, first-rate academic and co-curricular activities and has made life at GCU quite colourful and vibrant. The University takes pride in its pioneering work in histrionics under the GCU Dramatics Club, its inspiring orators from the Debating Society, its galaxy of respected editors of the prestigious publication The Ravi, editorial boards of The Gazette and The Scientific Ravi, its sports galas, and in its other bustling co-curricular activities round the year. The University thus provides ample opportunities to its students to discover themselves, to realise their potential and prepares them for the challenges of life.

2.1.1 Undergraduate Degree Programmes

Introducing the 4-Year (Hons.) Degree Programme is a major challenge for higher educational institutions in Pakistan. It is a well-known fact that the traditional 2-Year Bachelor's Degree clearly lagged behind, both qualitatively and quantitatively in the international academic world and the job market, where 16 years of education leading to Graduation is required. In order to produce graduates with quality education at par with international standards, the Higher Education Commission, Pakistan initiated major educational reforms by introducing the 4-Year BA/BSc (Hons) Degree Programme in public universities. The purpose was to enhance the acceptability of Pakistani graduates in job market as well as higher education institutions at national and international levels.

GC University Lahore being an institution well equipped with educational resources and requisite infrastructure, not only accepted this challenge, but also envisaged it as an opportunity to realize its vision of higher education in its disciplinary and interdisciplinary dimensions. Through persistent endeavour and commitment by a team of educationist and curriculum experts at GCU, a detailed scheme of study for BA/BSc (Hons.) Degree Programme was designed and introduced initially in four disciplines i.e. Economics, Chemistry, Physics and Mathematics in 2004.

At present, the University is offering BA/BSc 4-year (Hons.) Degree Programme in various disciplines. The BA/BSc 4-Year (Hons.) Degree Programme is an integrated Programme of higher education with a carefully planned curriculum, based on the most modern concepts of higher learning.

In accordance with the latest educational practices and theories of curriculum development and the guidelines provided by the Higher Education Commission, Pakistan, the 4-Year BA/BSc (Hons) Programme has been designed to provide freshmen with wide-ranging learning opportunities.

The practice of early narrow specialisation has been avoided and open disciplinary spaces have been created through a variety of subject combinations. The combinations of subjects offered at the beginning of the 4-Year (Hons) graduation Programme, fulfill

the academic and intellectual needs of students with diverse aptitudes and varied plans for future professions.

GC University Lahore has been a pioneer in the promotion of interdisciplinary learning in its Programmes of higher education. The same spirit and outlook has not only been preserved in the Programme, but has also been strengthened through the introduction of a higher order of interdisciplinary learning. This will equip young scholars with the conceptual basis and theoretical paradigms underlying their respective areas of disciplinary specialization. The GCU Administration is confident that this innovative strategy of scholarship will gradually bring about a transformation in the outlook of our students, and will go a long way in triggering creative processes essential for the production of scientific knowledge and the creation of artistic and literary works and will enhance the graduates' acceptability in the job market.

3. Department of Computer Science

3.1 Faculty of Department of Computer Science

1.	Prof. Dr. Syed Asad Raza Kazmi	Professor & Chairperson
2.	Mr. Saeed-ur-Rehman Turk	Assistant Professor
3.	Mr. Yahya Khurram	Assistant Professor
4.	Dr. Muhammad Safyan	Assistant Professor
5.	Dr. Muhammad Ilyas Fakhir	Assistant Professor
6.	Dr. Ayesha Atta	Assistant Professor
7.	Mr. Nadeem Zafar	Assistant Professor
8.	Dr. Awais Qasim	Assistant Professor
9.	Dr. Adnan Khalid	Assistant Professor
9.	Ms. Asma Kanwal	Lecturer
10.	Syed Ali Raza	Lecturer
12.	Mr. Ijaz Bukhari	Lecturer
13.	Mr. Atif Ishaq	Lecturer
14.	Mr. Touseef Iftikhar	Lecturer
15.	Mr. Muhammad Hafeez	Lecturer
16.	Ms. Aneeba Masood	Lecturer
17.	Ms. Hira Fayaz	Lecturer
18.	Mr. Umair Sadiq	Lecturer

3.1.1 Visiting Faculty

3.2 Department of Computer Science

The Department of Computer Science (DCS) at the GC University Lahore offers students and faculty a close-knit community in which to learn, discover, and innovate, in a shared quest for computational solutions to a spectrum of challenging problems. The DCS faculty are experts in their fields, including informatics, mobile communication, networking, security, software engineering, theory, and high performance computing. Recognised for high quality teaching and research, we attract staff and students from all cities of Pakistan. Driven by our research expertise and supported by excellent facilities, our undergraduate and postgraduate courses help students to develop their academic abilities and the essential skills required for the workplace such as evidence-based analysis and decision-making, problem-solving and project management skills. Future employability and career success are supported by our professional placement schemes.

The Department of Computer Science, GC University Lahore was established in 1999 as an independent Department in the Postgraduate Block of the GC University. At present, the Computer Science Department has 4 Computer Labs vis-à-vis postgraduate lab, main lab, general lab and ICS lab, and these labs comprising of more than 230 computers. The Department offers the following Academic Programmes.

1. Ph.D in Computer Science 3 Years Programme
2. MS in Computer Science 2 Years Programme
3. BS(Hons) in Computer Science 4 Years Programme

The Courses at Ph.D, MS and BS degree programs are approved through its Departmental Academic Committee and Departmental Board of studies by keeping in view the modern computing needs of both software industry and academic research.

3.3 Research at Department of Computer Science

The Department of Computer Science is an active department I research and running Ph.D programme. The research scholars are working in the areas of Web Semantic, Formal Methods, Real Time System Modeling, Cognitive Sciences, Machine Consciousness and Mobile Communication. The faculty and students produce number of research publications in International and National Journals. They have also actively participate in many International and National Conferences.

3.4 Facilities

The Department of Computer Science at the GC University Lahore prides itself on the excellent facilities we have to offer for both students and staff. We have a dedicated technical support team who is always available. The Department of Computer Science is equipped with the most up-to-date computers, labs and multimedia projectors available. Our class-rooms are fully air conditioned, and with a well-stocked library and round the clock internet facilities, everyone will find everything to make everyone's learning experience satisfying and enjoyable. Overall we have over 140 computers available for

student use and a number of wireless hotspots to enable students with laptops to access the campus network The CS department runs and administrates a network unit which provides optical inter-connectivity and internet facilities to the various departments of the Government College University. Besides the regular teaching to BS (CS) and MS (CS) programs the faculty of computer science is also engaged in teaching of computer related courses both at intermediate level (ICS) and B.A./B.S (honor) level offered by the GC University.

3.4.1 Computer Labs

The Department of Computer Science has a diversified collection of sophisticated com-puters installed at the cam-pus. Over 140 computers consisting of Core i3 and Core i5 are available to the student body for unlimited usage. All the computers are networked using Cisco routers and switches. The students have extensive exposure to multi-user, multitasking environment supported by various hardware resources and offering different software plat-forms including UNIX Architecture inter-connected through Local Area Networking (LAN). The Department staff is always alert to provide timely help to each stu-dent. The computing facilities at the University include the following three types of Computer Labs, namely, the Main Lab, General Lab and the Post Graduate Lab and Hardware Lab. They have the advantage of gaining unique experience of free and unlimited access to the facilities of the University Computer Labs, where each computer is attached with online printer and all machines are warranted uninterrupted operations because of individual protection by branded UPS system.

3.4.2 Microsoft Software Library

A complete range of licensed software development tools and operating systems are available to students and staff members. Students are provided with software free of cost. This facility is provided through the MSDNAA alli-ance with HEC and Microsoft Co. USA.

3.5 Student Societies

Co-Curricular societies are important part of the Department. They play a significant role in grooming students. Student chapters and branch, associated with different research embryonic, organizations such as ACM and IEEE, help students support themselves to latest research vicinities of their interest, through digital libraries, forums and publications. The Department of Computer Science provides funds to three societies that focus on arranging curricular and co-curricular activities. These societies are exclusively con-trolled by the Department with the help of its students. The Societies work in harmony to arrange different activities throughout semesters.

3.5.1 Computer Science Society

The Computer Science Society of GC University is actively playing its role for the es-tablishing and betterment of students. It is providing full opportunities to its students by

conducting market oriented seminars, on campus hiring by companies and conducting valuable training. The society had arranged a number of events within University and had participated in many competitions, seminars, etc outside the University.

3.5.2 ACM Society

GCU-ACM Student Chapter is actively working in collaboration with ACM USA, to promote the awareness of IT among students. Chapter has organized many activities like Industry Visits, Programming Competitions, Seminars, and Mentorship for students. Recently this society has generated a collaborative event with IEEE society namely Aptronix. The chapter has provided a platform for those students who want to enhance their knowledge and skill in different areas.

3.5.3 IEEE Society

The IEEE GCU Student Branch Lahore's current body was formulated in November 2008. It currently holds Seven Office Bearers and 9 Section Representatives. This student branch has been very active. It has not only participated in a variety of events but also organized them like Project Exhibition, Networking and Programming Quiz Competition and IEEE Members training workshop.

3.6 Sports

Department of Computer Science provides ample sports and recreational facilities to the students, in such diverse fields as Cricket, Hockey, Tennis, Gymnastics, Basket Ball, Table Tennis, Boxing, Swimming, Rowing, Squash. Athletics meets Gymkhana Sports and Hockey and Cricket matches are colorful and exciting events in the life of the City. The students of the Department have been actively participating in the inter-university competitions at the provincial as well as national level. The sports are managed by the Departmental Male and Female Sports coordinators.

3.7 Scholarship

Two types of scholarships: Merit scholarship and need based financial aids, are being offered to the students of Computer Science Department. In each semester, two merit scholarships will be awarded to the BSCS students having top grade point average (GPA). The deserving BSCS/MSCS students having good academic record but in financial constraint are allowed to avail the type of GC University scholarship for deserving students.

4. BS(Hons) in Computer Science

4.1 Introduction

The BS(Hons) in Computer Science a 4 years degree programme is a wide-ranging programme, encompassing both the theoretical and the practical. Our students are taught to apply computing to the world around them by building faster, smaller, and more secure software systems, exploring emerging technologies, and working on real-world problems. Our courses focus on teaching students how to recognize computational challenges, create elegant and efficient algorithms, and then use rigorous development methodologies to build systems that can solve pressing problems. Graduates of the BS(Hons) programme find successful careers with traditional software companies, government agencies, consulting firms, academia, and companies in other fields that have software needs.
Course work in the BS CS programme starts with several courses that introduce the basic principles of software creation, from learning programming languages to advanced development techniques. Once students have mastered the basics, the bulk of our program opens up, offering electives in several exciting fields, including networking, security, web programming, e-commerce, parallel computing, and much more. Students have the opportunity to take several electives in final year semesters.

4.2 Admission

The admission for BS(Hons) in Computer Science is usually offered/advertised after the Intermediate Examinations of the Intermediate Boards of the Punjab and before the declaration of Intermediate results as the Department of Computer Science will have schedule admission tests and interviews.

4.2.1 Eligibility

The applicant must fulfill the following criterion for admission to BS(Hons) in Computer Science at the Department of Computer Science GC University Lahore
Intermediate with Mathematics having minimum 50% marks, in one of the following combinations:

1. F.Sc (Pre-Engineering)
2. F.Sc (Pre-Medical with & without additional Mathematics)
3. General Science Group with following combinations:
   (a) Mathematics, Statistics, Physics
   (b) Mathematics, Computer Science, Physics
   (c) Mathematics, Computer Science, Statistics
   (d) Mathematics, Statistics, Economics
   (e) Mathematics, Computer Science, Economics
4. A-Level certificate with minimum B-Grade having same subjects mentioned above in Clause 1, 2 & 3.

NOTE: DAE diploma holders are not eligible to apply for BS(Hons) in Computer Science

4.2.2 Admission Process

The Department of Computer Science offers the admission for BS(Hons) in Computer Science once a year and this process usually begins in the month of July every year with admission advertisement in the daily news papers. The admission in this programme is equivalently available for both boys and girls who fulfill the criteria mention in section 4.2.1. A large numbers of applicants usually apply for the admission in BS programme every year against limited seats while the last year there were more than 5000 applicants for about 300 seats. While for the year 2015 there are 200 seats available on open merit. The Department of Computer Science offers two BS(Hons) in Computer Science Programmes namely

1. Morning Programme
2. Evening Programme

with same road map and courses but with a slight difference of fee structure, and these 200 seats are segregated as 120 seats and 80 seats for Morning and Evening programmes respectively. All eligible students will have to appear in the which will be conducted by the Department of Computer Science and usually held in the month of August every year.

The weightage of different academic parameters are as follows:

The weightage of Marks obtained in:	
Matriculation or Equivalent:	10%
ICS/F.Sc/A-Level or Equivalent:	40%
The Departmental Admission Test:	30%
The Departmental Interview:	20%
Total:	**100**

NOTE: It is mandatory to qualify interview which will be held after result of Departmental Admission Test

4.2.3 Programme Statistics:

DEGREE TITLE	**BS(Hons) in Computer Science**
MINIMUM PERIOD FOR DEGREE COMPLETION	**4 years**
TOTAL SEMESTERS	**8**
FINAL YEAR PROJECT CREDITS	**6 Credit Hours** (in Semester-7 & 8)
CREDIT HOURS OF THE DEGREE	**133 Credit Hours**

This text uses a different font typeface

4.3 BS COMPUTER SCIENCE ROADMAP

4.3.1 Introduction

The Course Outlines presented in this booklet is an outcome of continuous efforts of the Faculty of the Department of Computer Science GC University Lahore and these are chalked out keeping in view modern International and National trends in Computing while specially taken the "*Curriculum of Computer Science Information Technology & Software Engineering*" by the Higher Education Commission (HEC) of Pakistan presented in its revised edition 2017. The curriculum development is a continuous process in which the updating process takes place by looking at the changes that took place worldwide in the area of Computer Science and Technology thus our Faculty is consistently engaged in this process. The courses are segregated into number of domains as per HEC guidelines, and these are

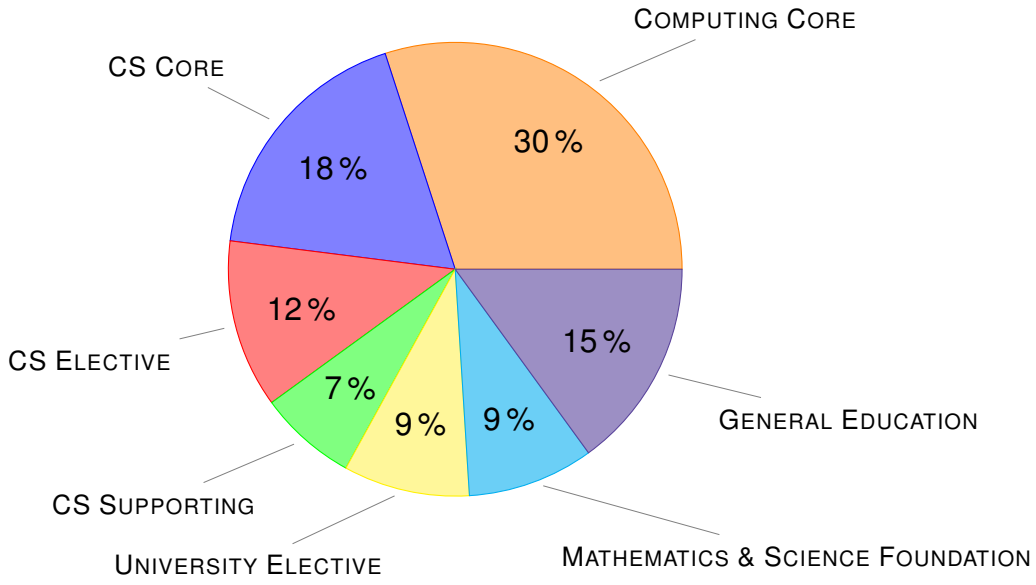
1. Computing Core Courses
2. Computing Supportive Courses
3. Computing General Education
4. Computer Science Core Courses
5. Computer Science Elective Courses
6. Computer Science Supportive Courses

7. University Elective Courses

As mentioned earlier the BS(Hons.) in Computer Science degree is of 133 credit hours and courses are segregated in various groups of courses as per Higher Education Commission(HEC) Islamabad's scheme for Computer Science curriculum 2017. These groups along with their percentage contribution is enlisted below.

AREAS COVERED IN BS(HONS.) IN CS PROGRAM			
COURSE GROUP	**CREDIT HOURS**	**%AGE**	**CODE USED**
General Education	19	15%	GE
University Electives	12	9%	UE
Mathematics & Science Foundation	12	9%	MSF
Computing Core	39	30%	CC
COMMON COURSES	**82**	**63%**	
COMPUTER SCIENCE DOMAIN			
Domain CS Core	24	18 %	CSC
Domain CS Electives	18	12%	CSE
Domain CS Supporting	9	7%	CSS
DOMAIN COURSES	**51**	**37%**	

The corresponding approximate weightage can be diagrammatically viewed as



4.3.2 Courses in Groups

The courses segregated in the aforementioned groups are enlisted here for guidance.

COMPUTING CORE COURSES		
COURSE TITLE	**CREDIT HOURS**	**PROPOSED SEMESTER**
Programming Fundamentals	3-1	I
Object Oriented Programming	3-1	II
Data Structures & Algorithms	3-1	III
Discrete Structures	3-0	III
Operating Systems	3-1	V
Database Systems	3-1	IV
Software Engineering	3-0	V
Computer Networks	3-1	
Information Security	3-0	VII
Final Year Project	0-6	VII & VIII
	TOTAL: 39(27-12)	

GENERAL EDUCATION COURSES		
COURSE TITLE	**CREDIT HOURS**	**PROPOSED SEMESTER**
English Composition & Comprehension	3	
Technical & Business Writing	3	
Communication & Presentation Skills	3	
Professional Practices	3	
Intro. to Info. & Comm. Technologies	2-1	
Pakistan Studies	2	
Islamic Studies/Ethics	2	
	TOTAL: 19(18-1)	

UNIVERSITY ELECTIVE COURSES		
COURSE TITLE	**CREDIT HOURS**	**PROPOSED SEMESTER**
Foreign Language: French, German, Arabic, Persian, Chinese, & Russian	3-0	
Management Related	3-0	
Social Science Related	3-0	
Economy Related	3-0	
	TOTAL: 12(12-0)	

The roadmap for BS(Hons) in Computer Science is summarized below in which courses are enlisted semester-wise.

SEMESTER-1				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-2210	Programming Fundamentals	4(3+1)	CC-1 $\left[\frac{4}{39}\right]$
2.	CS-1104	Introduction to Information & Communication Technology	3(2+1)	GE-1 $\left[\frac{3}{19}\right]$
3.	CS-ENG-1101	English Composition and Comprehension	3	GE-2 $\left[\frac{6}{19}\right]$
4.	CS-PK-2101	Pakistan Studies	2	GE-3 $\left[\frac{8}{19}\right]$
5.	CS-MATH-2201	Calculus and Analytical Geometry	3	MSF-1 $\left[\frac{3}{12}\right]$
6.	CS-Phy-1101	Applied Physics	3	MSF-2 $\left[\frac{6}{12}\right]$
			Total: 16-2	

SEMESTER-II				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-1201	Object Oriented Programming	4(3+1)	CC-2 $\left[\frac{8}{39}\right]$
2.	CS-2033	Digital Logic Design	4(3+1)	CSC-1 $\left[\frac{4}{24}\right]$
3.	CS-ENG	Communication & Presentation Skills	3	GE-4 $\left[\frac{11}{19}\right]$
4.	CS-MATH-2101	Linear Algebra	3	MSF-3 $\left[\frac{9}{12}\right]$
5.	CS-STAT-1101	Probability and Statistics	3	**MSF-4** $\left[\frac{12}{12}\right]$
			TOTAL: 15-2	

SEMESTER-III				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-2101	Data Structures and Algorithms	4(3+1)	CC-3 $\left[\frac{12}{39}\right]$
2.	CS-1203	Discrete Structures	3	CC-4 $\left[\frac{15}{39}\right]$
3.	CS-	Computer Organization & Assembly Language	4(3+1)	CSC-2 $\left[\frac{8}{24}\right]$
4.	CS-MATH-3201	Differential Equations	3	CSS-1 $\left[\frac{3}{9}\right]$
5.	CS-	University Elective Course-I	3	UE-1 $\left[\frac{3}{12}\right]$
			TOTAL: 15-2	

SEMESTER-IV				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-2014	Database Systems	4(3+1)	CC-4 $\left[\frac{19}{39}\right]$
2.	CS-3118	Design and Analysis of Algorithms	3	CSC-3 $\left[\frac{11}{24}\right]$
3.	CS-2044	Theory of Automata	3	CSC-4 $\left[\frac{14}{24}\right]$
4.	HM-3123	Professional Practices	3	GE-5 $\left[\frac{14}{19}\right]$
5.	CS-	Computer Science Elective-I	3	CSE-1 $\left[\frac{3}{18}\right]$
6.	CS-ISL-2101/CS-ETH-2101	Islamic Studies/Ethic	2	GE-6 $\left[\frac{16}{19}\right]$
			TOTAL: 17-1	

SEMESTER-V				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-2105	Software Engineering	3	CC-5 $\left[\frac{22}{39}\right]$
2.	CS-2205	Operating Systems	4(3+1)	CC-6 $\left[\frac{26}{39}\right]$
3.	CS-4207	Compiler Construction	3	CSC-5 $\left[\frac{17}{24}\right]$
4.	CS-4102	Graph Theory	3	CSS-2 $\left[\frac{6}{9}\right]$
5.	CS-41XX	Foreign Languages (French, German, Chinese, Arabic, Persian)	3	UE-2 $\left[\frac{6}{12}\right]$
			TOTAL: 15-1	

SEMESTER-VI				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-	Computer Networks	4(3+1)	CC-7 $\left[\frac{30}{39}\right]$
2.	CS-3102	Artificial Intelligence and Neural Networks	4(3+1)	CSC-6 $\left[\frac{21}{24}\right]$
3.	CS-	Computer Science Elective-II	3	CSE-2 $\left[\frac{6}{18}\right]$
4.	CS-	Computer Science Elective-III	3	CSE-3 $\left[\frac{9}{18}\right]$
5.	CS-	Computer Science Elective-IV	3	CSE-4 $\left[\frac{12}{18}\right]$
				TOTAL: 15-2

SEMESTER-VII				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-3216	Parallel & Distributed Computing	3	**CSC-7** $\left[\frac{24}{24}\right]$
2.	CS-4101	Principles of Programming Languages	3	**CSS-3** $\left[\frac{9}{9}\right]$
3.	CS-	Technical & Business Writing	3	**GE-7** $\left[\frac{19}{19}\right]$
4.	CS-	Computer Science Elective-V	3	CSE-5 $\left[\frac{15}{18}\right]$
5.	CS-	University Elective Course-III	3	UE-3 $\left[\frac{9}{12}\right]$
6.	CS-4018	Project	3	CC-8 $\left[\frac{33}{39}\right]$
				TOTAL: 15-3

SEMESTER-VIII				
No.	COURSE CODE	COURSE TITLE	CREDIT HOURS	COVERAGE
1.	CS-4215	Information Security	3	CC-9 $\left[\frac{36}{39}\right]$
2.	CS-	Computer Science Elective-VI	3	**CSE-6** $\left[\frac{18}{18}\right]$
3.	CS-	University Elective Course-IV	3	**UE-4** $\left[\frac{12}{12}\right]$
4.	CS-4018	Project	3	**CC-8** $\left[\frac{39}{39}\right]$
			TOTAL: 9-3	

4.3.3 LIST OF UNIVERSITY ELECTIVE COURSES

COURSE CODE	COURSE TITLE	CREDIT HOURS
CS – 1207	Financial Accounting	3
CS - 4217	Intellectual Property Rights and Cyber Law	3
CS - 4205	Entrepreneurship	3

4.3.4 COMPUTER SCIENCE SUPPORTING COURSES

COURSE CODE	COURSE TITLE	CREDIT HOURS
CS MATH – 3101	Multivariate Calculus	3
CS - 4216	Numerical Computing	3
CS -	Theory of Programming Languages	3
CS -	Graph Theory	3
CS -	Differential Equations	3

4.3.5 LIST OF CS ELECTIVES

SR. NO.	COURSE CODE	COURSE TITLE	CREDIT HOURS
1.	CS-3220	Software Quality Assurance	3
2.	CS-3228	Data Mining	3
3.	CS-3222	Image Processing & Computer Vision	3
4.	CS-2234	Web Engineering	3
5.	CS-3224	Natural Language Processing	3
6.	CS-3211	Wireless and Mobile Communication	3
7.	CS-3208	Data Warehouse & Mining	3
8.	CS-2224	Computer Graphics	3
9.	CS-3210	Digital Signal Processing	3
10	CS-3213	Embedded Systems	3
11.	CS-3209	Digital Image Processing	3
12.	CS-3212	Software Agents	3
13.	CS-3215	Semantic Web	3
14.	CS-3223	Software Development Process	3
15.	CS-3207	Advanced Software Engineering	3
16.	CS-	Database Design Theory	3
17.	CS-3227	Data Warehouse	3
18.	CS-3221	Design of Intelligent Robots	3
19.	CS-2201	Visual Programming	3
20.	CS-2208	Logical Paradigms in Computing	3
21.	CS-3109	Operations Research	3

Sr. No.	Course Code	Course Title	Credit Hours
22.	CS-4108	Object Oriented Analysis and Design	3
23.	CS-4104	Human Computer Interaction	3
24.	CS-4114	Software Model Checking	3

5. Courses Outlines

5.1 Semester-I

The courses details offered in **Semester-I of BS(Hons) in Computer Science** are given below with each course description, outlines, and some latest reference material & books.

5.1.1 Introduction to Information and Communication Technologies

Course Code:	Credit Hours:	Prerequisite:
CS-1104	**2+1**	**None**

Course Description:

Introduction to Computing, is a course to teach the essential ideas computers to an audience with no prior computer experience. This course is geared to use live code exercises most days in class – bringing the ideas to life, but without bogging down too much in computer idiosyncrasies. It is recommended to bring a laptop or tablet to lecture each day to follow along with the work. CS1101 is not as demanding as a full introductory-programming course.

COURSE OUTLINES:

Basic Definitions & Concepts, Hardware: Computer Systems & Components. Storage Devices, Number Systems, Software: Operating Systems, Programming and Application Software, Introduction to Programming, Databases and Information Systems, Networks, Data Communication, The Internet, Browsers and Search Engines, The Internet: Email, Collaborative Computing and Social Networking, The Internet: E-Commerce, IT Security and other issues, Project Week, Review Week.

REFERENCE BOOKS

1. Peter Norton (2006), *Introduction to Computers*, (6th Ed), McGraw-Hill.
2. Brian K. Williams, Stacey C. Sawyer (2015), *Using Information Technology: A Practical Introduction to Computer & Communications*, (11th Ed), McGraw-Hill.
3. *An Invitation to Computer Science*, Schneider and Gersting, Brooks/Cole Thomson Learning, 2000
4. Sarah E. Hutchinson, Stacey C. Swayer (1999), *Computers, Communications & information: A user's Introduction*, Irwin Professional Pub.
5. A. Leon, M. Leon (2009), *Fundamentals of Information Technology*, (2nd Ed), Leon press.

5.1.2 APPLIED PHYSICS

Course Code: **CS-PHY-1101** Credit Hours: **3**

Prerequisite: **None**

COURSE OUTLINES:

Electronics: Fundamentals of Semiconductor Physics: Band theory, Semiconductor (Intrinsic and Extrinsic), PNjunction: Diode Models and its characteristics, Diode as rectifier, Clipper, Clamper Circuits, Zener Diode and Voltage Regulator, LED, Transistors: Bipolar Junction transistors, BJT. Electromagnetism: Introduction Electricity, Electrostatics, Electromagnetism, amperes Law, Colombes Law, faraday Law. Magnetism & AC Quantities: Eddy current, DC motor, e/m of an electron, motion of charge, AC signals. Analog to digital converter/Digital to analog converter: Introduction to A/D and D/A Circuit. Logic Gates: (OR, AND, NAND, XOR, XNOR, NOT) Multivibrators Astable or Free running Multivibrator, Bi-Stable Multivibrator, Monostable Multivibrator and their applications.

REFERENCE BOOKS

1. H.D. Young and R.A. Freedman (2016), *University physics* (14th Ed), Pearson.
2. Resnick, Halliday and Krance (2001), *Physics* (5th Ed), Wiley.
3. Thomas L. Floyd (2017), *Electronics Devices* (10th Ed), Pearson.

5.1.3 CALCULUS AND ANALYTICAL GEOMETRY

Course Code: **CS MATH – 2201** Credit Hours: **3**

Prerequisite: **None**

Course Description:

This course is intended to broaden the students' ability to be efficient and creative problem solvers. It specifically addresses problems of motion and change, with an emphasis on the derivative. This course includes concepts of function, limit, continuity; derivatives and differentials, and techniques of integration.

COURSE OUTLINES:

Find Limit and Continuity of a Function. Find Limit of a Sequence. Calculate Continuity of Combinations of Functions. Find Properties of Continuous Functions. Find the derivatives of algebraic. trigonometric, exponential and inverse functions. Find the differential of a function using differentiation formulas. Derivative through Chain Rule. Calculate Higher Derivatives and Leibniz Rule. Calculate Partial Derivatives. Find Applications of Rolle's Theorem. Use Mean Value Theorem. Use Cauchy's Mean Value Theorem. Solve problems using Taylor and Maclaurin Series. Use L' Hospital's Rule for undefined form of limits. Calculate Integration by Substitution and by Parts. Calculate Integration of Rational, Irrational Functions and Trigonometric Functions. Application of Integral. Explore Applications of Parabola, Ellipse and Hyperbola. Find Tangents and Normals. Find Polar Coordinates. Find relation between Rectangular and Polar Systems. Find Maxima and Minima. Find Concavity and Point of Inflection. Find Second Derivative Test for Extrema. Find Application of Extrema. Find Singular Points. Find Area in Polar Coordinates. Find Differential of Arc Length. Find Double and Triple Integral. Find Lengths of Arc.

REFERENCE BOOKS

1. Thomas Finney (2014), *Calculus and Analytic Geometry* (9th Ed), Addison Wesley Longman.
2. Howard Anton, C. Bivens and Stephen Davis (2010), *Calculus* (10th Ed), Wiley.
3. S.M. Yusuf and Muhammad Amin (2005), *Calculus with Analytic Geometry for B.Sc & Engineering Students*, ILMI Kitab Khana.

5.1.4 ENGLISH COMPOSITION AND COMPREHENSION

Course Code: **CS ENG – 1101** Credit Hours: **3**

Prerequisite: **English Compulsory at Intermediate Level**

Course Description

This course aims at developing students reading and writing skills for academic purpose. The course lays special emphasis on the problems that trouble beginning writers. In practical terms, the course will teach and help students through each step from developing a sentence to organizing and writing a full-length essay. Students will be expected to develop their reading comprehension and writing skills through various tasks, activities and exercises.

COURSE OUTLINES:

Review some basic facts about sentences. What is a sentence? Identify incomplete sentences, run-together sentences and comma splices. Identify sentences with misplaced and dangling parts. Make sentences parallel Avoid shifts of tense. Use clear noun reference. Use various punctuation marks correctly. Rectify mistakes in punctuation. Follow the steps of the writing process. Discover, organize, draft, revise, edit and format an essay or a paper. Show how to survey a textbook. Show how to scan a book Show how to survey a textbook. Show how to scan a book. Explain how facts and ideas are connected. Examine the immediate context of the word. Reading for important points. Use cause and effect links. Recognize what is important. Show how the important points are linked.

REFERENCE BOOKS

1. Robey, C.L., Cheryl Jackson, Carolyn Melcher and Helen Malone (2002), *New Handbook of Basic Writing Skills* (5th Ed), Heinle & Heinle Pub.
2. Glendinning, Eric. H., (2004), *Study Reading , Cambridge* (2nd Ed), Cambridge University Press.
3. John E. Warriner (1986), *Warriner's English Grammar and Composition* (5th Ed), Harcourt Brace Jovanovich, Publishers.

5.1.5 PAKISTAN STUDIES

Course Code: **CS PK – 2101** Credit Hours: **2**

Prerequisite: **None**

Course Description:

This course outline has been designed for BS Computer Science, and divided into three modules; each module will concentrate on one particular issue at a time. Explain the genesis of Pakistan with reference to its ideology and two nation theory. Explain the constitutional development of Pakistan and concentrate on the economy of Pakistan with reference to its two its two major sector of agriculture and industrial. Overall the outline has been formulate not only to present the facts but also to inculcate sound understanding and critical approach in the students about Pakistan affair.

COURSE OUTLINES:

With reference to the creation of Pakistan, Ideology of Pakistan, War of independence and the subsequent role of Sir Syed Ahmed Khan, Growth of Separatism among Indian Muslims and Two Nation Theory, Allama Muhammad Iqbal - Idea of Pakistan, Demand of Pakistan and its fulfilment under the dynamic leadership of Quaid-e-Azam Muhammad Ali Jinnah, Political and Constitutional Development, Shaping of the state structure/Centralization, Objectives Resolution, Constitutions of 1956, 1962 and 1973, Democracy and Authoritarianism, Culture, Society and Religion, Definitions, Cultural roots, Materials and Non-Material Cultures, Role of religion in society, Ethnic diversity and pluralism, Contemporary Issues of issues in Pakistan, Unemployment, Education, Energy Crisis, Population Crisis, Governance Crisis, Health Issues, Foreign Policy of Pakistan, An overview of Pakistan's foreign policy, Geo-strategic importance of Pakistan, Basic principles and broad goals of Pakistan's foreign policy, Regional and international environment, Relations with India and Muslim World.

REFERENCE BOOKS

1. Sugata Bose and Ayesha Jalal (2011), *Modern South Asia (History, culture, political economy)*, (3rd Ed), Routledge.
2. Ian Talbot (2010), *A Modern History of Pakistan*, (2nd Ed), Palgrave Macmillan.
3. Tahir Kamran (2017) *Democracy and Governance*, Peace Publications.
4. Omar Noman (1988), *Political Economy of Pakistan*, (1st Ed), KPI Limited.
5. Ayeha Jalal (1995) *Democracy and Authoritarianism*, (1st Ed), Cambridge University Press.
6. Rafi Raza (2003), *Pakistan in Perspective*, Oxford University Press.
7. Tahir Amin, Foreign Policy of Pakistan.

5.1.6 PROGRAMMING FUNDAMENTALS

Course Code:	**CS – 2210**	Credit Hours:	**3+1**
Prerequisite:	**None**		

COURSE DESCRIPTION

In this course, students will learn a language for expressing computation-C++. They will learn about process of writing and debugging a program. Learning about the process of moving from problem statement to computational formulation of a method for solving the problem. Learning about the basic set of "recipes"-algorithms.

COURSE OUTLINES:

Learn about Programming Language and its importance, procedural process, Programming, Skill needed to programming, How to design a program, Software types, History of C, Tools to develop a program (editor, Compiler and Interpreter, Debugger, linker, loader), Moreover learning of language construct. Learn the variable name, type, size, value, Assignment operator, arithmetic operators, module operator, integer division, operator precedence, reserved word list, case sensitivity. How to reading and write on the output screen, assigning value to variable, analysis of problems,proper use of parenthesis and its precedence. Decision statement (if condition, relational operator, flow chart symbols, logical operators. , unary operators. complex statements including simple IF ,NestedIF and along with its flow chart. Multi-Way decisions(IF, ELSE-IF), SWITCH statements. Describe the use and implication of Repetitive structure. Learning of Repetitive Structure includes Simple FOR loop, WHILE loop, DO-WHILE loop. Increment and Decrement operator, compound assignment operator, break, continue statement and goto statement. Importance of modularization. Function (encapsulation, information hiding), call , declaration, definition, calling by value, calling by reference , function prototypes. Recursion. Header file, scope of identifier (local, global). Address of variable. Arrays, declaration, copy array to another array, comparing two character array, sorting array, searching from array (binary search, linear search), copy array to another array, Array passing to function. Strings(character arrays),null character, Sorting algorithms for array, Multidimensional array. Describe the Use and importance of pointers and String as well. Pointer , Pointer type, dereferencing, call by reference, use of constant in pointer, pointer increment, decrement, Pointer and arrays, Pointer arithmetic, Manipulation arrays with pointer, String Arrays with pointer. Single dereferencing , double dereferencing, pointer to pointer, array of pointer, command line argument. String handling, string manipulation function. Describe how to store the data on permanent storage and efficient use of memory. File handling, functions used in file handling. Structure, pointer with structure, pass structure to functions. Dynamic memory allocation.

REFERENCE BOOKS

1. D.S Malik (2012), *C++ Programming: From Problem Analysis to Program Design* (6th Ed), Course Technology Press Boston, MA, US.
2. Deitel and Deitel (2017), *C++ How to Program* (10th Ed), Pearson.
3. B.A. Frozen and R.F. Gilberg (2003), *Computer Science: A structured Programming Approach using C++* (2nd Ed), Course Technology.
4. Walter Savitch (2015), *Problem Solving with C++* (9th Ed), Pearson.

5.2 Semester-II

The courses details offered in **Semester-II of BS(Hons) in Computer Science** are given below with each course description, outlines, and some latest reference material & books.

5.2.1 Object Oriented Programming

Course Code: **CS – 1201** Credit Hours: **3+1**

Prerequisite: **Programming Fundamentals**

Course Description

This course is an introduction to the concepts of object-oriented paradigm. The combination of theory and programming will help students to develop their program writing and application designing skills. Lab work will help the students to analyze the real problem and solve it into the programming language. Assignments, quizzes, lab tests class participation and semester projects will be used as assessment tool to ensure and monitor students learning progress.

Course Outlines:

Overview of object-orientation. Overview of quality of software systems. Evolution of Object Oriented programming, OOP concepts and principles, problem solving in OOP paradigm, OOP design process, classes, methods, objects, encapsulation, constructors, operator, method overloading, overriding, inheritance, abstraction, polymorphism, GUI and error handling. Design and implementation. Object and Classes. Concept of Object and Classes, Methods, Parameters, Fields. Understand Class definitions, Constructors, Object Interaction, Creating Cooperating objects, Modularization Abstraction, Encapsulation, Object Type and Primitive Type, Grouping Objects, Collections, Array List, Array, Loops Iterator Objects, Class Libraries. Array List, Random, Interface and Implementation, Hash Map, Hash Set Java Packages and Import, Tokenizing String, Writing Class documentation Improving structure with inheritance, Inheritance, Sub typing, Sub Type Substitution, Polymorphic variables, Casting types, wrapper classes and autoboxing. Static and Dynamic type, Method polymorphism, Overriding inherited methods, Dynamic method lookup Protected access, Abstract Classes, Multiple Inheritance, Interfaces, Polymorphism with Interfaces, GUI principle, Components, Event Handling, Inner and Anonymous Classes, Layout Manager, Handling errors, Exception handling and throwing, Try, Catch, Final Construct, Error reporting, File handling, Multi Threading.

Reference Books

1. Deitel and Deitel (2017), *C++ How to Program* (10th Ed), Pearson.
2. Deitel and Deitel (2015), *Java How to Program* (10th Ed), Prentice Hall.

3. David J, Barne and, Michael Kolling (2016), ***Objects First with Java:*** *A Practical Introduction Using BlueJ* (6th Ed), Pearson.

5.2.2 DIGITAL LOGIC DESIGN

Course Code: **CS – 2033** Credit Hours: **3+1**

Prerequisite: **None**

COURSE OUTLINES:

Introduction of Digital and Analog representation, Binary, Octal, Decimal and Hexadecimal Number Systems, Conversion among various Number Systems, Binary Arithmetic, r's and r-1's Complements, Boolean algebra and Logic Simplification, The Karnaugh Map(K-Map), K-Map SOP minimization, K-Map POS minimization, Five variable K-Maps, Basic combinational Logic circuits, Implementing Combinational Logic, The universal property of NAND and NOR Gates, Combinational logic using NAND and NOR gates, Introduction to RTL, DTL, TTL, I2L, ECL and CMOS, Design of Basic Adders and subtractors, Design of Comparators, Design of Decoders, Design of Encoders, Design of Multiplexers, Design of Demultiplexers, Design of Parity Generators/checkers, Introduction to Sequential Circuits, RS Latch, RS Flip Flop (Asynchronous, Synchronous), CLR, PRESET inputs, Clocked D Flip Flop, Clocked JK Flip Flop, Master Slave Flip Flop Clocked T-Flip Flop, Counters, Design and applications of SISO, SIPO, PISO, PIPO and Bidirectional shift registers, Memory and Storage, Introduction to Digital and Analogue Interfacing, Design Digital to Analog (D/A) and Analog to Digital (A/D) conversion Circuits, Introduction to Programmable Logic Devices, States Machines, Introduction to FPGA (Field Programmable Gate Array), CPLD (Complex Programmable Logic Devices), Introduction to HDL/VHDL, Introduction to Xilinx, Xilinx Software.

REFERENCE BOOKS

1. Thomas L. Floyd (2001), *Digital Fundamentals* (8th Ed), Prentice Hall.
2. Ronald J. Tocci (2001), *Digital Systems: Principles and Applications* (8th Ed) Prentice Hall.
3. Steve Waterman (2002), *Digital Logic Simulation and CPLD Programming with VHDL* (1st Ed) Prentice Hall.
4. William Kleitz (2002), *Digital Electronics: A Practical Approach* (6th Ed) Prentice Hall.
5. Nigel P. Cook (2001), *Digital Electronics with PLD Integration* (1st Ed) Prentice Hall.
6. A.PaulMalvino and Donald P. Leach (1992) *Digital Principles* (5th Ed), McGraw Hill Co.

5.2.3 DIGITAL LOGIC DESIGN((PRACTICAL)

Course Code: **CS-2033(P)** Credit Hours: **3+1**

Prerequisite: **None**

COURSE OUTLINES:

Verification and interpretation of truth tables for Logic Gates, Application of Universal NAND Gate, Application of Universal NOR-Gate, hardware implementation of combinational logic circuits such as multiplexers and de-multiplexers, encoders/decoders, Parity Generator/Checker, implementation of sequential circuits such as flip-flops, registers, shift registers, counters and other digital circuits. Verification of Functionality of AND, OR, NAND, NOR and NOT Gate & Combinational Logic using VHDL with Test Bench

REFERENCE BOOKS

1. Thomas L. Floyd (2001), *Digital Fundamentals* (8th Ed), Prentice Hall.
2. Ronald J. Tocci (2001), *Digital Systems: Principles and Applications* (8th Ed) Prentice Hall.
3. Steve Waterman (2002), *Digital Logic Simulation and CPLD Programming with VHDL* (1st Ed) Prentice Hall.
4. William Kleitz (2002), *Digital Electronics: A Practical Approach* (6th Ed) Prentice Hall.
5. Nigel P. Cook (2001), *Digital Electronics with PLD Integration* (1st Ed) Prentice Hall.
6. A.PaulMalvino and Donald P. Leach (1992) *Digital Principles* (5th Ed), McGraw Hill Co.

5.2.4 LINEAR ALGEBRA

Course Code: **CS MATH – 2101** Credit Hours: **3**

Prerequisite: **Calculus & Analytical Geometry**

COURSE DESCRIPTION

In this course following topics will be covered: Matrices and Matrix Operations, Linear Systems of Equations, Gaussian Elimination, Rank, Matrix Inverses, Determinants, Gauss-Jordan Elimination, Linear Transformations, Inner Product, Orthogonality, Eigenvalues and Eigenvectors, Complex Matrices, Diagonalization, Vector Algebra, Vector Product, Vector and Scalar Functions and Fields, Curves, Tangents, Arc Length, Curves in Mechanics, Gradient, Divergence, Curl, Line Integrals Independent of a Path, Green's Theorem, Surface Integrals.

COURSE OUTLINES:

Use of Matrices. Find Algebra of Matrices. Find Inner Product of Vectors. Find Rank of a Matrix. Find Determinants of a Matrix. Calculate Inverse of a Matrix. Applications of Matrix Multiplication. Solve Systems of Linear Equations. Solve Equations by Gauss Elimination Method. Solve Equations by Gauss-Jordan Elimination Method. Find Solution for Consistency Criterion. Solve Equations by Cramer's Rule. Find Orthogonality and Linear Transformations. Solve Matrix Eigenvalue Problems. Find Eigenvalues and Eigenvectors. Applications of Eigenvalues and Eigenvectors. Find Symmetric, Skew-Symmetric and Orthogonal Matrices. Solve Complex Matrices. Calculate Similarity of Matrices.

REFERENCE BOOKS

1. Erwin Kreyszig (2006), *Advance Engineering Mathematics* (9th Ed), Wiley India.
2. S.M. Yusuf & Muhammad Amin (2005), *Mathematical Methods for B.Sc & Engineering Students*, ILMI Kitab Khana.
3. Bernard Kolman, David Hill (2007), *Elementary Linear Algebra with Applications* (9th Ed), Prentice Hall PTR.
4. Howard Anton, Chris Rorres (2005), *Elementary Linear Algebra: Applications Version* (9th Ed), Wiley.

5.2.5 COMMUNICATION & PRESENTATION SKILLS

Course Code: **CS ENG – 1202** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course is designed to develop the ability of students to focus on outcome, tune in to audience and develop message for clarity and impact. The ability to create an environment for open discussion and ongoing dialogue is crucial for communication success. The communication skills covered in this course will increase students' ability to exercise choice and control for every type of conversation, influence without authority and improve quality of relationships and productivity. Moreover, Report Writing aims at preparing students for writing effective academic and business reports. To achieve this goal, different classroom strategies such as lecturing, multimedia presentations, and group discussions will be pursued. Moreover, students will be asked to write reports, and regular feedback will be provided by the course instructor.

COURSE OUTLINES:

Principles of writing good English. Understanding the composition process, Writing clearly; words sentences and paragraphs. Comprehension and expression. Use of grammar and punctuation, Process of writing: Observing audience and collecting information, Persuasive writing, Composing, drafting and revising. Reading skills: Critical thinking and evaluation of the text, Listening skills and comprehension, Skills for taking notes in class. Skills for preparation of exams. Business Communication: Planning messages, writing concisely but impact fully, Letter format and mechanics of business letter writing, Memos, applications, summaries and proposals, Writing resumes; styles and formats. Oral Communication: Verbal and non-verbal communication, Conducting meetings, small group communication and taking minutes. Presentation skills: Presentation strategies, Defining the objective, scope and audience of the presentation ,Material gathering and organization strategies, Time management; opening and concluding, Use of audio-visual aid and Delivery and presentation

REFERENCE BOOKS

1. Raymond V. Lesikar and Marie E. Flatley (2000), *Basic Business Communication* (10th Ed), Richard D Irwin.
2. *Perdue Writing Lab* (Perdue University).

5.2.6 PROBABILITY AND STATISTICS

Course Code: **CS STAT – 1101** Credit Hours: **3**

Prerequisite: **Elementary Mathematics**

COURSE DESCRIPTION

Introduction to statistical experimentation and research methods with applications to natural and social sciences. This course introduces students to the major concepts and tools for collecting, analyzing, and drawing conclusions from the primary as well as the secondary data. The four broad conceptual themes are exploring data, planning a study, anticipating patterns, Systematic coverage of the more widely used statistical methods, including simple regression and correlation. Students are expected to make a presentation in an applied field and complete a data-based project as part of the course requirement.

COURSE OUTLINES:

Statistics: Definition and explanation. Branches of Statistics. Descriptive Statistics & Inferential Statistics. Statistics in decision making Examples. Graphical representation of Data, Stem-and leaf plot. Box plots & Whisker diagram. Histogram and Ogive. Measure of Central Tendencies: (Mean Median and Mode. Geometric Mean, Harmonic Mean). Dispersion for grouped and ungrouped data: Variance, Standard Deviation and Co-Efficient of Variation. Mean Moments of frequency distribution. Examples with real life data. Use of Elementary statistical packages for explanatory data analysis. Counting Techniques. Definition of probability with classical and relative frequency and subjective approaches. Sample space. Events, Laws of probability. General Probability Distribution. Conditional Probability. Bayes theorem with application to random variable. Binomial Distribution with real life data. Poisson Distribution with real life data. Hyper Geometric Distribution with real life data. Normal Distribution with real life data. Simple Linear Regression. Correlation & Rank Correlation. Statistical Packages.

REFERENCE BOOKS

1. Ronald Walpole, Myers, Myers, Ye (2008), *Probability & Statistics for Engineers & Scientists* (8th Ed)Prentice Hall Publisher.
2. Lay L. Devore (2011), *Probability and Statistics for Engineering and the Sciences* (8th Ed), Cengage Learning.
3. Cowan (1998), *Statistical Data Analysis* (1st Ed), Oxford University Press.

5.3 Semester-III

The courses details offered in **Semester-III of BS(Hons) in Computer Science** are given below with each course description, outlines, and some latest reference material & books.

5.3.1 COMPUTER ORGANIZATION & ASSEMBLY LANGUAGE

Course Code: **CS-2108** Credit Hours: **3+1**

Prerequisite: **None**

COURSE DESCRIPTION

This is a basic course aimed to improve the scientific knowledge of the students. This course helps the students to know about different electronic circuits and components used in computer hardware. How to interact with computer hardware through low-level language.

COURSE OUTLINES:

Computer Arithmetic, Integer representation, integer arithmetic, floating-point representation, floating-point arithmetic, Instruction Sets: Characteristics and Functions Machine Instruction Characteristics, Types of Operands, Pentium Data Types, Types of Operations, Instruction Sets: Addressing Modes and Formats Addressing, Pentium Addressing Modes, Instruction Formats, Pentium Instruction Formats, Introduction to Assembly Language with debug, Structure of Assembly Language Programs and Flag Register, Control Flow Instructions, Addressing Modes, Stack & Procedures, Bit Manipulation Instructions, Macros, Interrupts, Multiplication and Division Instructions.

REFERENCE BOOKS

1. William Stallings (2010), *Computer Organization and Architecture*, (8th Ed), Pearson.
2. Ytha Yu, Charles Marut (1992), *Assembly Language Programming and Organization IBM PC*, (1st Ed), McGraw-Hill.
3. Muhammad Ali Mazidi (2009), *X86 PC: Assembly Language, Design, and Interfacing*, (5th Ed) Prentice Hall.

5.3.2 DISCRETE STRUCTURES

Course Code: **CS – 1203** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Introduction to logic and proofs: Direct proofs; proof by contradiction, Sets, Combinatorics, Sequences, Formal logic, Prepositional and predicate calculus, Methods of Proof, Mathematical Induction and Recursion, loop invariants, Relations and functions, Pigeonwhole principle, Trees and Graphs, Elementary number theory, Optimization and matching. Fundamental structures: Functions; relations (more specifically recursions); pigeonhole principle; cardinality and countability, probabilistic methods. Discrete structures and computer algorithms are considered to be the building blocks in design of Social Interactive Agents. This course will give students a comprehensive introduction of common discrete structures for Natural Language Processing (NLP) in the AI applications, Robots/Agent.

COURSE OUTLINES:

Introduction. Overview of Discrete Structures, Programming recap. The Foundations: Logic and Proofs. Propositional Logic, Propositional Equivalences, Predicate and Quantifiers. Basic Structures: Sets, Functions, Sequences, Sums and Matrices, Sets, Functions, Sequence and Series, Matrices. Algorithms, Growth of Algorithms, Complexity of Algorithm Induction and Recursion, Mathematical Induction, Recursive Definition and Structural Induction, Recursive Algorithm, Program Correctness. Recursion, Recursion Concept, Recursion Tree, Recursion Classical Examples, Recursion Processes Memory Model, Recursion Process Analysis, Recursive sorting (Merge Sort). Discrete Probability, Introduction to Discrete Probability, Probability Theory, Baye's Theorem, Expected Value and Variance. Graphs, Graphs and Graphs Models, Representing Graphs and Graph Isomorphism, Euler and Hamiltonian Path, Shortest Path Problem, Planar Graphs, Graph Colouring. Trees, Introduction to Trees, Tree Traversal, Spanning Tree, Minimum Spanning tree. Boolean Algebra , Boolean Functions, Logic Gates, Minimization of circuit. Modelling Computation, Languages and Grammars, Finite-State Machines with output, Finite-State Machines with no output, Language Recognition, Turing Machines.

REFERENCE BOOKS

1. Kenneth H. Rosen (2006), *Discrete Mathematics and Its Applications* (7th Ed), Mcgraw Hill Book Co.
2. Richard Johnsonbaugh (2008), *Discrete Mathematics* (7th Ed), Prentice Hall Publishers.
3. Kolman, Busby and Ross (2000), *Discrete Mathematical Structures* (4th Ed), Prentice-Hall Publishers.

4. Ralph P. Grimaldi (2003), *Discrete and Combinatorial Mathematics: An Applied Introduction* (5th Ed), Addison-Wesley Pub. Co.

5.3.3 Data Structures and Algorithms

Course Code: **CS – 2101** Credit Hours: **4**

Prerequisite: **None**

Course Description

Data structures are the building blocks of complex data manipulation applications and algorithms are the program designs to construct, traverse and store these data structures.

Course Outlines:

Overview of data types and data structures, Arrays & Pointers, Recursion, Array Processing, Searching, Sorting algorithms. 2-D arrays and matrices, Complex array operations. Sparse matrices, Stack, Stack implementation, Push/Pop operations, Stack as machine, Expression evaluation, Complex stack operations, Linked list implementation of stack. Queue, Queue Structure and implementation. Add/remove or Enque/Dequeue Operations. Different implementations of Queue. Linked list, circular queue, priority, queue. Double ended queue. Linked Lists, Node object and operations, Singly and doubly/Circular linked list operations. Linked List class and its operations. Tree data structures, Tree based searching and sorting algorithms, Heaps, binary tree. General Tree. Expression Tree and General Expression solver. Huffman's Tree and data compression. Game tree. Graphs, General Graph structure, Graph Construction, traversal, search operations. DFS, BFS, Prim's and Kruskul Algorithms. Shortest Path Algorithms', Dijikstra's Algorithm. Practical Applications. 2D array as graph, Games, complex algorithms based on graphs.

Reference Books

1. Tenenbaum (2015), *Data structures Using C and C++* (2nd Ed), Pearson India.
2. E. Horowitz, S. Sahni and D. Mehta (1995), *Fundamentals of data structures in C++* (1st Ed), W. H. Freeman.
3. Mark Allen Weiss (2011), *Data Structures and Algorithm Analysis in Java* (3rd Ed), Addison-Wesley.
4. Robert Sedgewick (1997), *Algorithms in C++, Parts 1-4: Fundamentals, Data Structure, Sorting, Searching* (3rd Ed), Addison-Wesley Professional.

5.3.4 DIFFERENTIAL EQUATIONS

Course Code: **CS MATH – 3201** Credit Hours: **3**

Prerequisite: **Calculus & Analytical Geometry**

COURSE DESCRIPTION

In this course following topics will be covered: First-Order Differential Equations, Separable Equations, Homogeneous Equations, Equations Reducible to Homogeneous, Exact Differential Equations, Integrating Factor, Linear Equations, Bernoulli Equations, Orthogonal Trajectories in Cartesian and Polar Coordinates, Applications of First Order Differential Equations, Linear Differential Equations of Second and Higher Order, System of Differential Equations, Phase Plane, Quantitative Methods, Series Solutions of Differential Equations, Special Functions and Partial Differential Equations.

COURSE OUTLINES:

Explain First Order Differential Equations. Explain Basic Concepts and Ideas. Find Separable Differential Equations. Find Exact Differential Equations. Find Linear Differential Equations. Calculate Orthogonal Trajectories. Calculate Existence and Uniqueness of Solutions. Solve Linear Differential Equations of Second and Higher Order. Solve Homogeneous Differential Equations of Second Order. Find Euler-Cauchy Equation. Solve Nonhomogeneous Equations. Solve by Undetermined Coefficients and Variation of Parameters. Solve Higher Order Linear Differential Equations. Solve Higher Order Homogeneous and Nonhomogeneous Equations. Solve Systems of Differential Equations. Calculate Series Solutions of Differential Equations. Solve Legendre's Equation. Solve Bessel's Equation. Find Orthogonal Functions. Find Partial Differential Equations. Calculate Separation of Variables. Use Laplace's Equation in Cylindrical and Spherical Coordinates. Find Solution by Laplace Transforms. Applications of DE for problems to daily life.

REFERENCE BOOKS

1. Erwin Kreyszig (2006), *Advance Engineering Mathematics* (9th Ed), Wiley India.
2. H .Edwards, David E. Penney (2013), *Elementary Differential Equations With Applications* (6th Ed), Prentice Hall.
3. Michael Greenberg (1998), *Advanced Engineering Mathematics* (2nd Ed), Pearson.
4. Zill, Prindle, Weber and Schmidt (2000), *A First Course in Differential Equations* (5th Ed), Brooks/Cole Publishing.
5. Dennis G. Zill, Michael R. Cullen (2017), *Differential Equations with Boundary-Value Problems* (9th Ed), Brooks/Cole Publishing.

5.4 Semester-IV

The courses details offered in **Semester-IV of BS(Hons) in Computer Science** are given below with each course description, outlines, and some latest reference material & books.

5.4.1 Database Systems

Course Code: **CS – 2014** Credit Hours: **4**

Prerequisite: **None**

Course Description: Basic database concepts; Entity Relationship modeling, Relational data model and algebra, Structured Query language; RDBMS; Database design, functional dependencies and normal forms; Transaction processing and optimization concepts; concurrency control and recovery techniques; Database security and authorization. Small Group Project implementing a database. Physical database design: Storage and file structure; indexed files; b-trees; files with dense index; files with variable length records; database efficiency and tuning.

Course Outlines:

Introduction of Database. Discuss difference between Data, information and Data processing. Difference between Manual file based system and Computerized file based system. Explain Database and types of database. Explain the Database Management system and the Components of DBMS. Explain the relationship between DBMS and Application program. Explain Database System Architecture. Explain the three-level Architecture, External view level, Conceptual view level and internal view level. Discuss Mapping, External-conceptual mapping and conceptual-Internal mapping. Explain Database Data dependencies and Models. Discuss Data Independence , Logical and Physical Data independence. Explain the purpose of Data Dictionary and Database languages i.e. DDL and DML. The concepts of Data Models. Database Development process and Database Administration. Discuss and Explain the database Development process. Discuss first three phases out of six phases with scenarios i.e. Database planning, Requirement Analysis and Design. Discuss the concept of SQL. Advancement in Database Development process and Database Administration. Explain the next three phases out of six phases with scenarios i.e. DBMS Selection, Implementation and Operational maintenance. Discuss the SQL Statements i.e. Create, Select. Discuss with example the select statement with clauses. Entity-Relationship Model. Explain the Entity-Relationship Model. Explain the Element of E-R Model, Entity types, entity instance. Explain the Attributes and types of attributes. Entity Identifier, Key attributes with examples. Functions i.e. Sum, Max, Min, Avg, functions in SQL. Relationship in E-R Model. Entity Identifier, Key attributes with examples. Discuss the concept of Relationship between the entities. Discuss the Degree of relationship. Relationship Types in E-R Model. Discuss Types of relationship. Discuss the cardinalities of relationship. Relationship in E-R Model. Modeling Multi-valued Attributes, Modeling Repeating Groups. Discuss the Aggregation and Generalization. The Relational Data Model. Discuss Relational Data Model. Discuss the concept of relation in

Mathematical and relational model. Discuss the properties of relation and relation keys. Discuss the data integrities and referential integrity. Discuss. Normalization. Problems associated with Data Redundancy. Update anomalies. Functional Dependencies and Keys 1st NF,2nd NF, 3rd NF, Boyce-Codd Normal Form, 4th NF. Transaction management and concurrency control. Transaction Management and Concurrency control: What is a Transaction; Evaluating Transaction Results, Transaction Properties, Transaction Management with SQL, Transaction Log, Transaction Types. Concurrency Control: Lost Updates, Un-committed Data, Inconsistent Retrievals, Dirty Data, Fuzzy Read, Scheduler. Concurrency Control with locking Methods: Lock Granularity, Lock Types, Two-Phase Locking to Ensure Serializability Deadlocks. Concurrency control with Time Stamping Methods: Concurrency control with optimistic Methods. Database Recovery Management; Transaction Recovery, Architectural Considerations, Recovery information. Data Warehousing Concepts. Discuss the difference between databases and Data warehouse. Discuss various features of data warehouse. Discuss architectures of DWH. Discuss Extraction, Transformation and Loading of data into data warehouse. Discuss the concept of data marts, super marts and dicing, slicing pivoting, information cubes for data analysis.

REFERENCE BOOKS

1. C.J Dates (2003), *Introduction to Database* (8th Ed), Pearson.
2. Catherine Recordo (1990), *Database Systems: Principles Design and Implementation*, Macmillan Coll Div.
3. R.Connolly and P. Begg (2009), *Database Systems: A Practical Approach to Design, Implementation and Management* (5th Ed), Addison-Wesley Pub.
4. Elmasri and Navathe (2015), *Fundamentals of Database Systems* (7th ed), Pearson.

5.4.2 Design and Analysis of Algorithms

Course Code: **CS – 3118** Credit Hours: **3**

Prerequisite: **Programming Fundamentals/OOP,**

Data Structures & Algorithms

Course Description

Algorithms have been the core of thinking for logicians, scientists and mathematicians for the centuries. Chinese remainder theorem is an ancient algorithm, designed some five thousand years ago. From 16th Century, Mathematicians and logicians started designing procedures for solution of complex problems. The procedures employed simple steps in a sequence and normally were arranged in repeated loops or recursively. Taylor and McLaurin series are such algorithms which were widely used for solution of mathematical and physics problems, centuries before the invention of computing machines.

Course Outlines:

The Role of algorithms in computing. Model of Computation, Designing Techniques and Growth of functions, Asymptotic Notations. Analysis of Algorithms. Recurrences; The Recursion-Tree method for solving Recurrences, The Master Method for Solving Recurrences and The Substitution Method for Solving Recurrences. Heaps, Maintaining Heap Property, Building Heap, The Heap-Sort Algorithms and Priority Queues. Insertion Sort, Merge Sort, Quick-Sort, Description of Quick-Sort, Performance of Quick-Sort, A randomized Version of Quick-Sort, Analysis of Quick-Sort and Linear-Time Sorts, Counting Sort, Radix Sort and Bucket Sort. Data Structures, Binary Search Trees, Red Black Trees, Balancing of RB Trees and Rotations. Dynamic Programming and Greedy Algorithms. Graphs, Techniques to Traverse the Graphs (DFS, BFS), Topological Sort, Connected Components, Minimum Spanning Tree.

Reference Books

1. T. H. Cormen, C. E. Leiserson, R. L. Rivest, and C. D. Stein (2009), *Introduction to Algorithms* (3rd Ed), MIT Press.
2. Knuth, Donald Ervin (1997), *The Art of Compter Programming* (3rd Ed), Addison-Wesley.
3. Brain W. Kernighan and Rob Pike (1999), *The Practice of Programming*, Addison-Wesley.
4. Standish, Thomas A. (1995), *Data Structures, Algorithms and Software Principles in C*, Addison-Wesley.
5. Brain W. Kernighan and Dennis Ritchie (1998), *The C Programming Language* (2nd Ed), Prentice-Hall.

5.4.3 THEORY OF AUTOMATA

Course Code: **CS – 2044** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course is an introduction to the concepts of Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (DFA & NFA), Transition graphs (TGs), Kleene's theorem, Transducers (automata with output), Pumping lemma and non regular language Grammars Context free grammars, Derivations, derivation trees and ambiguity, Simplifying CFLs , Normal form grammars and parsing, Push-Down Automata, Introduction to Turing machines, Variations on TM, Universal Turing Machine, Defining Computers by TMs.

COURSE OUTLINES:

Introduction to Formal Proof and Inductive Proofs. The Central Concepts of Automata Theory. Overview of Formal Languages. Finite Automata. Transition Graphs. Deterministic & Nondeterministic Finite Automata. Finite Automata With Epsilon Transitions. Conversion from NFA to DFA. Kleene's Theorem. Regular Expression and Languages. Finite Automata and Regular Expressions. Applications of Regular Expressions. Algebraic Laws for Regular Expressions. Properties of Regular Languages. Proving Languages Not to Be Regular (Pumping Lemma). Closure Properties of Regular Languages. Decision Properties of Regular Languages. Finite State Machines with Output, Transducers (Moore and Mealy machines). Context-Free Grammars and Languages. Parse Trees. Applications of Context-Free Grammars. Ambiguity in Grammars and Languages. Properties of Context-Free Languages. Normal Forms for Context-Free Grammars. Closure Properties of Context-Free Languages. Chomsky Normal Form. Pushdown Automata (PDA). Definition of the Pushdown Automaton. The Languages of a PDA, Equivalence of PDAs and CFGs. Introduction to Turing Machines. The Extension of Turing Machine. Programming Techniques for Turing Machines Post Turing Machine. Variations on Turing Machine. Turing Machine Encoding. Universal Turing Machine Defining Computers by Turing Machines.

REFERENCE BOOKS

1. J.E. Hopcroft, R. Motwani, J.D. Ullman (2006), *Introduction to Automata Theory, Languages and Computation* (3rd Ed), Pearson.
2. Peter Linz (2011), *An Introduction to Formal Languages and Automata* (5th Ed), Jones & Bartlett Publishers.
3. P. K. Srimani, S. F. B. Nasir (2007), *A Textbook on Automata Theory*, Cambridge University Press India Pvt. Limited.

4. S.P. Eugene Xavier (2008), *Theory of Automata, Formal Languages and Computation*, New Age International Pvt. Ltd.
5. Daniel I. A. Cohen (1996), *Introduction to Computer Theory* (2nd Ed), Wiley.

5.4.4 PROFESSIONAL PRACTICES

Course Code: **HM – 3123** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Computing Profession: Professional Bodies and code of conduct, professional ethics in computing, professional competency and life long learning, social context of computing and professional responsibilities; Organizations and their structures: Company organization: software house organization. Organizational behavior, employee relationship, interpersonal relations, conflict resolution; Legal issues: software and computer contracts; Software industry related intellectual property rights, copyright law, patents, trademarks and licensing; privacy and civil liberties, regulation and control of personal information, data protection, defamation; computer crime, computer misuse and the criminal law; risks, safety and liabilities of computer based systems.

COURSE OUTLINES:

Understanding the dynamics of working in office Team management. The need for teams. Team construction. Team or group differences. Authority responsibility or delegation. Recruitment or selection. Recruitment or selection process. Process or responsibilities. Factors that effect the frequency of recruitment process. Assessment criteria. Effective Recruitment. Recruitment or selection plan. Process for recruitment. Use for media. Job description or personnel specification Job description. Job analyses. Method for analyses. Selection methods. Appropriate methods. The selection inter view. Purpose, skills involved. Training and development. The learning process. Retention training development. Duties of training manager. Methods for individual development. Benefits of training. Training needs analysis. Staff evaluation methods. Management development. In house or external training. Competence Assessment. Process or barriers. Staff/ Appraisal. Conducting the appraisal inter view. Management skill involved. Key communicant on skills. Skills development. Skills development program. The mentoring process. Management of Health or safety. Health and safety awareness. Controlling conflict grievance or discipline Appeal process. Motivation or leadership. Motivational theories. Reward Scheme.

REFERENCE BOOKS

1. Stephen P. Robbins and Timothy A. Judge (2015), *Organizational Behavior* (15th Ed), Pearson Education Inc.
2. Gary Dessler (2007), *Human Resource Management* (11th Ed), Prentice Hall.

5.4.5 ISLAMIC STUDIES

Course Code:	**CS ISL – 2101**	Credit Hours:	**2**
Prerequisite:	**None**		

Course Description

This introductory course of Islamic Studies(Compulsory) teaches the fundamentals of both Beliefs and practices to the students of B.A/B.Sc. (Honors) semester one. It will cover the basic issues of Islamic way of life, Characteristics of individual behavior, Overview of Islam as a code of conduct. It discusses the role of Islamic teachings both in the individual as well as social life. It discusses not only the worships but also the social, ethical, economic, political and judicial issues of human life.

COURSE OUTLINES:

Describe the core Concepts, principles of Social and their relevance in the social and political systems. Describe and illustrate Prophetic way of purification as well as establishing a common wealth. Describe civilization, Islamic civilization, its characteristics and how this civilization affected the other civilizations. Describe the present concept of clash of civilizations, how this clash can be minimized or at least its hazards can be reduced. Selected Quranic Text and Prophetic Traditions.

REFERENCE BOOKS

1. Khan Muhammad Chawala, *Adan Islamiyat*, Adan Publications Urdu Bazar, Lahore.
2. Dr. Muhammad Hameed Ullah (1986), "Introduction to Islam", SH. Muhammad Ashraf Pub.

5.4.6 ETHICS

Course Code: **CS ETH – 2101** Credit Hours: **2**

Prerequisite: **None**

Course Description

This course is an introduction to the philosophical study of morality, including the theory of right and wrong behavior, the theory of value (goodness and badness), and the theory of virtue and vice. Besides providing familiarity with the primary questions addressed within moral philosophy and the most influential answers given by well-known philosophers, this course is designed to help students develop their abilities to read, explicate, analyze, and evaluate philosophical literature, write and express themselves well about their own ethical positions, and think critically and analytically about ethical issues.

COURSE OUTLINES:

Definition of Ethics, Morality, Conduct and Character. Various aspects of Ethical problems including: The good, the right, moral law, conscience, virtue, duty, pleasure, altruism and self-sacrifice. Types of Ethical theory: Hinduism, Rationalism, Eudemonism. Temperance or Self-discipline, Culture or self-development. The Social virtues, Justice, Benevolence, The social organism of life. The theory of punishment. Ethical teaching of major religions: Hinduism, Judaism, Christianity, Buddhism, Islam.

REFERENCE BOOKS

1. J. S. Mackenzi(2005), *A Manual of Ethics* (Reprint Edition), Published by Cosimo, Inc.
2. James Seth (1905), *A study of Ethical Principles* (8th Ed), Published by Blackwood.
3. Milton A. Gonsalves (1990), *Rights and Reasons: Ethics in Theory and Practice* (9th Ed), Published by Pearson.
4. Serrans and Hospers (1952), *Reading in Ethical Theory*, Published by New York : Appleton-Century-Crofts.
5. W. T. Jones (1969), *Approaches to Ethics*, Published by Mcgraw-Hill.

5.5 Semester-V

The courses details offered in Semester-V of BS(Hons) in Computer Science are given below with each course outlines, its goals and objectives and some latest reference material & books.

5.5.1 Operating Systems

Course Code: **CS – 2205** Credit Hours: **3+1**

Prerequisite: **None**

Course Description

Operating systems are central to computing activities. An operating system is a program that acts as an intermediary between a user of a computer and the computer hardware. Two primary aims of operating systems are to manage resources (e.g. CPU time, memory) and to control users and software. Operating system design goals are often contradictory and vary depending of user, software, and hardware criteria. This course describes the fundamental concepts behind operating systems, and examines the ways that design goals can be achieved.

Course Outlines:

Introduction of Operating Systems. Function of Operating Systems. Structural components of Operating Systems. Operating System Operations. Introduction of Operating Systems. Process Management. Memory Management. Protection Management. Operating System Structures. OS Services. System Calls, System Programs. Operating System Structures. Processes. PCB, Context Switching, Process States. Schedulers, CPU and IO Bound. Process Life Cycle. Scheduling Queues. Process Creation and Termination. Spawning and Cascading. Dispatcher Work Model. CPU Scheduling. Preemptive and Non Preemptive Scheduling. CPU Utilization, Throughput. Turnaround Time, Response Time, Waiting Time. Scheduling Algorithms. Priority Scheduling and Concept of Aging, Round Robin Scheduling Algorithm, Virtual Round Robin. Scheduling Algorithm. Process Synchronization. Cooperating and Independent Processes, Producer/Consumer Algorithm, Inter-process Communication, Direct / Indirect Communication, Mailboxes, Synchronization. Methods to Implement, Mutual Exclusion, Progress and Bounded Wait Conditions, Mutual Exclusion Algorithms, Peterson's Algorithm. Concept and Definition, Conditions for Deadlock, Deadlock Representation, Resource Allocation Graph, Assignment and Request Edges, Cycle Existence. Methods to Handle Deadlocks, Deadlock Prevention, Deadlock Avoidance, Safe State and Safe Sequences Concurrency and Deadlock Algorithms. Dinning Philosopher Problem. Memory Addresses, Address Bindings, Memory Management Unit, Logical and Physical Addresses, Overlays and Swapping. Paging and Segmentation. Paging, Paging Address Translation (Paging and Frames). Segmentation, Base and Limit Registers.

REFERENCE BOOKS

1. Silberschatz A. (2008), *Operating Systems Concepts* (8th Ed), Wiley.
2. B. Kernighan and R. Pike (1984), *The UNIX Programming Environment* (1st Ed), Prentice-Hall.
3. Leland L. Beck (1996), *System Software: An Introduction to Systems Programming* (3rd Ed), Pearson.

5.5.2 SOFTWARE ENGINEERING

Course Code: **CS – 2105** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course is aimed at helping students build up an understanding of how to develop a software system from scratch by guiding them thru the development process and giving them the fundamental principles of system development with object oriented technology using UML. The course will initiate students to the different software process models, project management, software requirements engineering process, systems analysis and design as a problem-solving activity, key elements of analysis and design, and the place of the analysis and design phases within the system development life cycle.

COURSE OUTLINES:

The Software Process. Software and Software Engineering Process: A Generic View. Prescriptive Process Models Agile Development. Software Engineering Practice. Practice: A Generic View System Engineering. Requirements Engineering Analysis Modeling. Design Engineering Architectural Design. Component-Level Design User Interface Design. Software Testing Strategies, Software Testing Techniques. Product Metrics for Software. Applying Web Engineering. Web Engineering. Formulation and Planning for Web Engineering, Analysis Modeling for Web Applications. Design Modeling for Web, Applications Testing Web Applications. Managing Software Projects. Project Management Concepts Process and Project Metrics. Estimation for Software Projects Software Project Scheduling. Risk Management, Quality Management. Change Management. Advanced Topics in Software Engineering. Formal Methods. Cleanroom Software Engineering, Component-Based Software Engineering. Reengineering the Road Ahead.

REFERENCE BOOKS

1. Roger Pressman (2014), *Software Engineering: A Practioner's Approach* (8th Ed), McGraw-Hill.
2. Ian Sommerville (2001), *Software Engineering* (7th Ed), Addison-Wesley.

5.5.3 COMPILER CONSTRUCTION

Course Code: **CS – 4207** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course introduces the fundamental concepts in compiler design. The topics covered include scanner and parser designs and implementation, program shape analysis, intermediate code generation, and back-end optimizations such as instruction selection and scheduling. The goal is to familiarize students with basic structure of a typical modern compiler and help them implement several sample compiler phases (passes) typically one from front-end and one from back-end. Another goal is to help them understand the implementation consequences of the choices made in programming language design.

COURSE OUTLINES:

The Structure of a Compiler. Introduction to the Phases of a Compiler. Lexical Analysis. Role of Lexical Analyzer. Lexical Analysis Versus Parsing. Tokens, Patterns, and Lexemes. Attributes for Tokens. Lexical Errors. Specification of Tokens. Strings and Languages, Operations on Languages, Regular Expressions. Recognition of Tokens. Recognition of Reserved Words and Identifiers. Architecture of a Transition-Diagram-Based Lexical Analyzer. The Design Lexical-Analyzer Generator. Use of Lex/Flex. Structure of Lex/Flex Programs. DFA's for Lexical Analyzer. Optimization of DFA-Based Pattern Matchers. Syntax Analysis. The Role of the Parser. Syntax Error Handling. Error-Recovery Strategies. The Formal Definition of a Context-Free Grammar. Parse Trees and Derivations. Context-Free Grammars Versus Regular Expressions. Lexical Versus Syntactic Analysis. Removing Ambiguity by Eliminating Left Recursion and Left Factoring in Top-down Parsing. Top-Down Parsing (LL(1) Parser). Recursive-Descent Parsing. FIRST and FOLLOW. Parsing Table. Working of Recursive-Decent Parser. Bottom-Up Parsing. Shift-Reduce Parsing. Working of Bottom-Up Parser. Parser Generators, Yacc/Byacc. Intermediate-Code Generation. Directed Acyclic Graphs for Expressions. The Value-Number Method for Constructing DAG's. Three-Address Code. Addresses and Instructions. Quadruples & Triples. Types and Declarations. Type Expressions, Type Declarations. Storage Layout for Local Name. Sequences of Declarations. Rules for Type Checking. Flow-of-Control Statements. One-Pass Code Translation of Switch-Statements. Intermediate Code for Procedures. Code Generation Phase.

REFERENCE BOOKS

1. Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman (2007), *Compilers: Principles, Techniques, and Tools* (2nd Ed), Addison-Wesley Pub. Co.
2. Dick Grune, Henri E. Bal, Ceriel J. H. Jacobs and Koen G. Langendoen (2012), *Modern Compiler Design* (2nd Ed), Springer.

3. Andrew W. Appel, Maia Ginsburg (2004), *Modern Compiler Implementation in C*, Cambridge University Press.

5.5.4 GRAPH THEORY

Course Code: **CS – 4102** Credit Hours: **3**

Prerequisite: **Discrete Structures**

COURSE DESCRIPTION

This course will provide the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs, and Trees etc. Formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles. Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography. Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular.

COURSE OUTLINES:

Introduction to Graph Theory, Basic definitions, computer representations and properties of Graph, Data structure for representing Graphs, Fundamental theorem of Graph Theory, Isomorphic and Special Graphs, Properties of Trees and Forests, Binary tree, Balanced binary tree, Directed and Undirected rooted tree, Minimum Spanning Tree algorithms and implementation, Path and Distance in graphs, Shortest path algorithms and implementation, Cycle and distance in weighted graph and digraphs, Distance algorithms and implementation, Eulerian graphs and Hamiltonians graphs with applications, Flow networks, Max-flow Min-cut Theorem, Graph coloring, Edge coloring, Planar graphs, Four color theorem, Deadlock of computer system, Matching Algorithms, Dominance & Ramsey theory.

REFERENCE BOOKS

1. Fournier (2011), *Graph Theory & Applications* (1st Ed), Published by Wiley-ISTE.
2. Chartrand (1995), *Applied Algorithmic Graph Theory* (1st Ed), Published byMcGraw-Hill College.
3. Jonathan (2004), *Handbook of Graph Theory* (Series Edition), Published by CRC Press.
4. J. A. Bondy (1982), *Graph Theory with Applications* (8th Ed), Published Elsevier USA.

5.5.5 FRENCH

Course Code:	**CS – 4111**	Credit Hours:	**3**
Prerequisite:	**None**		

COURSE DESCRIPTION

Level A1 according to the Common European Framework of References for Language.

COURSE OUTLINES:

Read and understand simple texts and other written material dealing with everyday and familiar topics. Read and understand the main content of simple instructions and directions. Understand common, everyday words and simple expressions as well as simple, slow and distinct conversation pertaining to oneself, family and specific areas of interest. Understand simple instructions and directions in everyday situations when spoken slowly and clearly. Produce basic written information about oneself, complete simple forms and questionnaires. Produce short, very simple texts which comprehensively describe a familiar situation, (e.g. write a short letter or message). Participate in basic conversation about everyday situations and general areas of interest, (e.g. family, housing, studies or equivalent) in which other participants speak slowly and clearly, and are prepared to assist. Use simple vocabulary and phrases, ask and answer basic questions about known topics of conservation and situations. (e.g. greetings, shopping terminology, asking for assistance and help).

REFERENCE BOOKS

1. Guy Capelle and Robert Menand (2014), *Le Nouveau Taxi* (Vol. 1), Published by Hachette.
2. Michele Bosquet, Matilde Martinez and Yolanda Rennes (2008), *Pourquoi Pas*, Published by Difusion.
3. Claire Miquel (1991), *Communication Progressive Du Francais: Niveau Debutant* (French Ed), CLE International.

5.5.6 GERMAN

Course Code: **CS – 4106** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Level A1 according to the Common European Framework of References for Language.

COURSE OUTLINES:

Introduction and comparison of German, English, Urdu, International words in German, Alphabet, sounds, pronunciation, Counting, Introducing yourself and others, Greetings and Conversation, Introduction to regular verbs, Articles-definite, indefinite and negative (der, die, das/ein, eine/kein/keine) Personal pronoun and conversation, Nouns-(singular and plural), Helping Verb, Basic Verb with conjugation, and Conversation Separable Verb and conversation, Modal Verb, Verb with conjugation, and Conversation, Question with Verb Revision, Present perfect Conversation, Time-/ days / month / year, Schedule, Appointment, meeting Conversation, Traveling Vocabulary and conversation, Family Vocabulary and conversation, Food Vocabulary and conversation. German names of cities and countries.

REFERENCE BOOKS

1. Heiner Schenke and Karen Seago Routledge (2004), *Basic German: A Grammar and Workbook* (1st Ed), Heiner Schenke and Karen Seago.
2. Ulrich Haussermann Georg Dietrich Christiane C. (1997), *Sprachkurs Deutsch Unterrichtswerk fur Erwachsene*, Gunther Diethelm Kaminski Ulrike Woods Hugo Zenkner.
3. Rinehart and Winston Holt (2003), *Komm Mit! Holt German* (Level 1), Holt, Rinehart And Winston.

5.5.7 CHINESE

Course Code: **CS – 4107** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Level A1 according to the Common European Framework of References for Language.

COURSE OUTLINES:

Introduction to Chinese Mandarin, Chinese Pinyin, Formal and informal Greetings, Initials and finals, Tones in Chinese languages: Neutral tone, Change of tones, Phonetic alphabets, Numbers counting and colours. Prepositional constructions, How to tell time, Grammatical function of time words, making an acquaintance: how to ask name and Introduce oneself, Question with interrogative pronouns; sentence with verbal predicate (grammar). Making an Inquiry: how tell about birthday, telling about family, time, days of a week, month, and year, telling about address: sentence with nominal predicate and propositional construct and affirmative-negative question (grammar). Locations and Directions; Asking about market, fruits and money; The modal particles and verbs (grammar). Asking about visit to places: Beijing, Zoo, and party; he aspect particle, The complement of degree and the object, the adjective as a complement of result (grammar). Introduction about invitation and visit, apology, regret and congratulation; The affirmative-negative question (grammar).

REFERENCE BOOKS

1. Elinor Greenwood (2007), *Easy Peasy Chinese* (1st Ed), DK Children.
2. Kang Yuhua and Lai Siping (2006), *Conversational Chinese 301* (3rd Ed), Beijing Language and Cultural University Press Beijing.
3. Yuehua Liu (2008), *Integrated Chinese: Simplified Characters Textbook* (3rd Ed), Cheng & Tsui.

5.5.8 RUSSIAN

Course Code: **CS – xxxx** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Level A1 according to the Common European Framework of References for Language.

COURSE OUTLINES:

Introduction and comparison of Russian, English, Urdu vocabulary and international words in Russian. Alphabet, sounds, pronunciation, counting, introducing yourself and others, greetings and conversation, introduction to regular verbs, genders (masculine, feminine, neuter), personal pronouns, nouns (singular and plural), basic verbs and conjugation, modal verbs and conjugation, questions, Present Tense, time / days / months, schedule, appointment, meeting conversation, travelling vocabulary and conversation, family vocabulary and conversation, food vocabulary and conversation, Russian names of people, Russians names of cities and countries.

REFERENCE BOOKS

1. Rachel Farmer (2003), *Beginner's Russian: An easy introduction*, Hudder & Stoughton Educational Inc, UK.
2. Janna Andrianova (2006), *Russian Phrase book and dictionary*, (3rd Ed), Berlitz Publishing Company, Moscow, Russian Federation.
3. Miller, L.V., Politova L.V., Rybakova I.Y. Zhili-byli (2009), *(Once upon a time) 28 lessons for beginners*, (8th Ed), Zlatoust, St. Petersburg, Russian Federation.

5.5.9 ARABIC

Course Code: **CS – 4109** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Objectives of the Course	1. To enable students to Reade and comprehend selected text of Arabic 2. To learn grammer of Arabic Language and apply its rules practically. 3. To enable them to speak Arabic
Course Description	
Topic	**Description**
Arabic Grammer	1. نکرہ و معرفہ 2. واحد جمع اور مذکر و مونث 3. مرکب توصیفی و مرکب اضافی 4. جملہ اسمیہ و جملہ فعلیہ 5. فعل ماضی و فعل مضارع 6. فعل امر و فعل نہی 7. حروف جارہ، ادوات الاستفہام 8. حروف جازمہ مضارع، اسمائے جازمہ مضارع 9. افعالِ ناقصہ 10. حروف مشبہ بالفعل
Suggested Books for Grammer	1. عربی کا معلم (حصہ اول و دوم): عبد الستار خان 2. معلم الانشاء (حصہ اول): عبد الماجد ندوی
Study of Arabic Text	1. طریقہ جدیدہ از ڈاکٹر محمد امین مصری جزو اول و جزو ثانی

5.5.10 PERSIAN

Course Code: **CS – 4110** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

اسم اشارہ جملہ حال مثبت، منفی و پرسئی، مصدر کی پہچان اور کچھ مصادر، ساعت، منزل من، باغ ملی، فارسی نظم تدریس، پنج درسگاہ، خانوادہ من، جملہ اسمیہ معرفہ، نکرہ ہ فارسی میں واحد سے جمع بنانا، فعل کی اقسام، ماضی قریب و ماضی بعید، ماضی شکیہ، ماضی شرطیہ، ماضی تمنائی، فعل حال فعل مستقبل، فعل حال جاری، فعل حال جاری، فعل مضارع، فعل امر و نہی، اسم معرفہ و اسم نکرہ، صفت، ضمیر فارسی، فعل ہادی سال و برنامہ من، اعضای بدن، پیغمبر ما، فارسی نظم میازار موری کہ دانہ کش، غذائی ما و مطب پذ شک، روز ہادی فتہ ازم، مسافرت از، پند ھاری، علامت گزاری، معرفی خودتان کید

Reference Books

1) سبط حسن رضوی و دکتر و علی رضا نقوی و گلشن و فارسی (کتاب اول) و رایزنی فرہنگی جمہوری اسلامی ایران و اسلام آباد و ص 2007

2) سلیم مظہر دکتر محمد فارسی گفتاری و آموزش فارسی 2 اورئنٹل پبلی کیشنز پاکستان و لاہور و 2007

3) عباس خاموری مدیر مسئول آموزش فارسی و مقدماتی خانہ فرہنگ جمہوری اسلامی ایران لاہور 2012

4) فلیحہ زاہرا کاظمی و جدید کلید مصادر و اورئنٹل پبلی کیشنز پاکستان و لاہور و 2009

5) یداللہ ثمرہ و آموزش زبان فارسی دورہ ء مقاماتی کتاب اول ادارہ کل بین الاقوامی تعاون و تلعلقات و وزارت فرہنگ و ارشاد اسلامی و 1373 ش و درس اول مداہا و انضبای فارسی آموزش زبان فارسی

5.6 Semester-VI

The courses details offered in **Semester-VI of BS(Hons) in Computer Science** are given below with each course description, outlines, and some latest reference material & books.

5.6.1 Computer Networks

Course Code: **CS – 3201** Credit Hours: **3+1**

Prerequisite: **None**

Course Description

Analogue and digital Transmission, Noise, Media, Encoding, Asynchronous and Synchronous transmission, Protocol design issues. Network system architectures (OSI, TCP/IP), Error Control, Flow Control, Data Link Protocols (HDLC, PPP). Local Area Networks and MAC Layer protocols (Ethernet, Token ring), Multiplexing, Switched and IP Networks, Inter-networking, Routing, Bridging, Transport layer protocols TCP/IP, UDP. Network security issues. Programming exercises, labs or projects involving implementation of protocols at different layers.

Course Outlines:

Explain Data Communications and Networking for Today's Enterprise, Explain Communications Model, Components of Data Communications, Explain Network and types of Network (LAN, WAN, MAN & Wireless LAN), also explain different LAN topologies, Explain Internet and it's Configuration, Explain the need for Protocol Architecture, Explain TCP/IP protocol architecture in detail, discuss different protocols working at different layers, Discuss comparison of TCP/IP with OSI Model, Explain popular protocols in detail (TCP, UDP, HTTP, FTP, SMTP etc.) Explain standardization within a Protocol Architecture and discuss traditional Internet-Based applications, Explain Digital and Analog signals and characteristics of signals, Discuss Analog transmission, Digital transmission, Explain Transmission Impairments and discuss Channel Capacity theory (Nyquist and Shannon), Explain guided transmission media, Discuss wireless transmission and wireless propagation techniques also discussion transmission impairments specific to wireless line-of-sight transmission, Explain Line of sight propagation and mobile transmission in detail, Explain data encoding schemes (Digital Data - Digital Signal, Analog Data - Digital Signal, Digital Data - Analog Signal, Analog Data - Analog Signal) in detail, Explain the Synchronous and Asynchronous transmission, Explain types of error also discuss error detection techniques (Parity and CRC) in detail, discuss Line configuration in detail, Describe flow control in data link control, Explain Stop and Wait flow control in detail, Explain different techniques of error control in detail (Stop and Wait ARQ, Go back N ARQ, Selective Reject ARQ), Discuss the High Level Data Link (HDLC) protocol functionality, Describe the concept of Frequency Division Multiplexing and Time Division Multiplexing, Discuss concept of Circuit switching, Discuss Circuit switching networks

and control signaling in circuit switching. Explain Packet switching principles and two types of packet switching (Datagram & Virtual Circuits), Discuss packet size in packet switching, Describe the comparison of circuit switching and packet switching.

REFERENCE BOOKS

1. William Stallings (2013), *Data and Computer Communications* (10th Ed), Prentice Hall.
2. Andrew Tanenbaum (2012), *Computer Networks* (5th Ed), Pearson.
3. Behrouz A. Forouzan (2012), *Data Communications and Networking* (5th Ed), Science Engineering & Math.
4. James F. Kurose and Keith W. Ross (2012) *Computer Networking: A Top-Down Approach Featuring the Internet*, (6th Ed), Pearson.

5.6.2 COMPUTER NETWORKS(PRACTICAL)

Course Code: **CS-3201P** Credit Hours: **1**

Prerequisite: **None**

COURSE OUTLINES:

Define Network and types of Communication Networks (LAN, WAN, MAN, Wireless), Discuss types of Network Topologies, Explain Transmission media used in Computer Networks (guided & un-guided), Discuss Computer Network devices, Explain Network address (MAC and IP), Classification of IP addresses,
Practical #1 Implementation of cross-wired cable and straight through cable using clamping tool
Practical #2 Study of Network devices in detail
Practical #3 Study of Network IP addressing schemes
Practical #4 Connect Computers/Terminals in Local Area Network
Practical #5 Study of basic Network commands and Network configuration commands
Practical #6 Configure a Network topology using packet tracing software
Practical #7 Configure a Network using Distance Vector Routing protocol
Practical #8 Configure a Network using Link State Vector Routing protocol
Hardware Requirements: RJ-45 Connectors, Clamping Tool, Twisted Pair Cable Software Requirements: Command Prompt and Packet Tracer, Network Simulators (Antidote, Cloonix, CORE etc)

REFERENCE BOOKS

1. William Stallings (2013), *Data and Computer Communications* (10th Ed), Prentice Hall.
2. Andrew Tanenbaum (2012), *Computer Networks* (5th Ed), Pearson.
3. Behrouz A. Forouzan (2012), *Data Communications and Networking* (5th Ed), Science Engineering & Math.
4. James F. Kurose and Keith W. Ross (2012) *Computer Networking: A Top-Down Approach Featuring the Internet*, (6th Ed), Pearson.

5.6.3 ARTIFICIAL INTELLIGENCE AND NEURAL NETWORK

Course Code: **CS – 3102** Credit Hours: **3+1**

Prerequisite: **None**

COURSE DESCRIPTION

Course aims to provide knowledge of designing and programming intelligence systems having ability to learn and make decisions based on their believes and knowledge. Furthermore, this course also provides in depth knowledge on modeling of systems using bio-inspired algorithms like genetic algorithms and neuro-computing. It aims to master the problem solving skills using artificial intelligence and neural networks methods.

COURSE OUTLINES:

Explain how A.I. is different from tradition computing system. Motivate students by explaining the association between various discipline of computer science and artificial intelligence. Discuss in detail the central dogma of computer science and artificial intelligence. Communicate Alan Turing's concept related to machine becoming intelligent. Discuss various school of thoughts on artificial intelligence including weak artificial intelligence, strong artificial intelligence, neat artificial intelligence, scurfy artificial intelligence. Applications and Success stories on artificial Intelligence. Discuss the technological singularity and role of artificial intelligence. Discuss different approaches to machine intelligence. Discuss various methods to make machines intelligence including GOFAI, Cybernetics, Sub-symbolic AI, Evolutionary Computing, Intelligent Agents, Quantum Artificial Intelligence and Artificial Life including wet, hard and soft life. Discuss intelligent Agents. Discuss Machine Learning. Explain supervised, unsupervised and reinforcement learning using demonstration clip of ASIMO. Discuss various methods to implement machine learning. Discuss various data preparation and encoding techniques for machine learning. Discuss Neural Networks. Explain how human brain works and what the structure of a neuron is. Construct a back-propagation neural network to simulate supervised learning. Problem Solving By Searching. Problem solving agents. Apply different searching algorithms. Discuss Genetic Algorithms and Darwin theory. Discuss Belief Networks. Discuss Bayesian theorem and its applications.

REFERENCE BOOKS

1. Stuart Russell and Peter Norvig (2009), *Artificial Intelligence: A Modern Approach* (3rd Ed), Pearson.
2. G. F. Lugar (2006), *Artificial Intelligence: Structures and Strategies for Complex Problem Solving* (6th Ed), Pearson.

5.6.4 Artificial Intelligence and Neural Network(Practical)

Course Code: **CS-3102** Credit Hours: **1**

Prerequisite: **None**

Course Outlines:

This course is aimed providing a practical/tutorial content to enable students understand the course on Artificial Intelligence & Neural Networks through ”hands on” practice. Each lab session shall begin with a theoretical introduction to the topic under discussion, followed by problem solving methodology and concludes with Exercise problems. The main topics which will be covered are problem solving by informed and uninformed searching, Constraint satisfaction problems and Adversarial search will be programmed by students. Second section of this lab includes genetic algorithms. Third section is based on Belief Networks through which students will be able to formulate the example where uncertainty is high and traditional computing fails to evaluate the situation. Last section is related to Artificial Neural Networks (ANN). The section begins with laboratory session on implementation of basic logic function, and is followed by methods of creating and working on ANNs. Next lab session describes problems solving phases of ANNs; and finally the effect of external have been observed on the performance of ANNs.

Reference Books

1. Lab Manual prepared by course teacher & Course Coordinator.

5.7 Semester-VII

The courses details offered in Semester-VII of BS(Hons) in Computer Science are given below with each course outlines, its goals and objectives and some latest reference material & books.

5.7.1 PARALLEL & DISTRIBUTED COMPUTING

Course Code: **CS – 3216** Credit Hours: **3**

Prerequisite: **Computer Networks**

COURSE DESCRIPTION

This course covers general introductory concepts in the design and implementation of parallel and distributed systems, covering all the major branches such as Cloud Computing, Grid Computing, Cluster Computing, Supercomputing, and Many-core Computing. The specific topics that this course will cover are: asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, and synchronization.

COURSE OUTLINES:

Why use parallel and distributed systems? Why not use them? Speedup and Amdahl's Law, Hardware architectures: multiprocessors (shared memory), networks of workstations (distributed memory), clusters (latest variation). Software architectures: threads and shared memory, processes and message passing, distributed shared memory (DSM), distributed shared data (DSD). Possible research and project topics, Parallel Algorithms, Concurrency and synchronization, Data and work partitioning, Common parallelization strategies, Granularity, Load balancing, Examples: parallel search, parallel sorting, etc. Shared-Memory Programming: Threads, Pthreads, Locks and semaphores, Distributed-Memory Programming: Message Passing, MPI, PVM. Other Parallel Programming Systems, Distributed shared memory, Aurora: Scoped behaviour and abstract data types, Enterprise: Process templates. Research Topics.

REFERENCE BOOKS

1. B. Wilkinson and M. Allen (1999), *Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers* (1st Ed), Prentice Hall.

2. W. Stevens (1993), *Advanced Programming in the Unix Environment*, Addison Wesley.

5.7.2 PRINCIPLES OF PROGRAMMING LANGUAGE

Course Code: **CS – 4101** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course focuses on the principles of programming languages. Topics covered include programming paradigms, concepts of programming languages, formal syntax and semantics, and language implementation issues.

COURSE OUTLINES:

Introduction: Models of Computation, Syntax and Semantics, Pragmatics, Language Design Principles. Syntax and Semantics: Context-Free Grammars, Regular Expressions, Attribute Grammars and Static Semantics, Algebraic Semantics, Axiomatic Semantics, Denotational Semantics. BNF grammars and Syntax, Operational Equivalence, Abstraction and Generalization, Expressions, Assignment Statement, and Control Structures, Functional Programming: The Lambda Calculus, Operational Semantics, Reduction Order, Recursive Functions, Logic Programming, Inference Engine, Concurrency.

REFERENCE BOOKS

1. Mike Grant, Zachary Palmer, Scott Smith (2016), *Principles of Programming Languages*, John Hopkins University.
2. Robert W. Sebesta (2015), *Concepts of Programming Languages*, (11th Ed), Pearson.
3. Scott, Michael L. (2009), *Programming Language Pragmatics*, (3rd Ed), Morgan Kaufmann.
4. Anthony A. Aaby (2004), *Theory Introduction to Programming Languages*, Walla Walla College.

5.7.3 TECHNICAL AND BUSINESS WRITING

Course Code: **CS-ENG-4101** Credit Hours: **3**

Prerequisite: **None**

COURSE OUTLINES:

Overview of Technical Reporting: Use of library and information gathering, Administering questionnaires, Reviewing the gathered information. Technical exposition, Topical arrangement, Exemplification and definition, Classification and division, casual analysis, Effective exposition and technical narration, Description and argumentation, Persuasive strategy, organizing information and generating solutions, Brainstorming and organizing materials, Construction of the formal outline, outlying conventions, Electronic communication and generating solutions. Polishing style: Paragraphs, listening sentence structure, clarity, length and order, Pomposity, empty words and pompous vocabulary. Document design : Document structure, preamble, summaries and abstracts, Table of content, footnotes and glossaries, Cross-referencing and plagiarism avoidance, Citation and bibliography, Glossary, index, appendices and type-setting systems. Creating a professional report: Elements, mechanical and graphical elements, Reports, Proposals and progress reports, Leaflets and brochures, and books and magazine articles, Research papers and feasibility reports, Project reports and technical research reports, Manuals, documentations and thesis, Electronic documents; linear versus hierarchal structure document.

REFERENCE BOOKS

1. Technical Report Writing, by Pauley and Riordan, Houghton Mifflin Company (8th Edition, 2001)
2. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill (2005)
3. Handbook of Technical Writing by Gerald J. Alerd, Charless T. Brusaw and Walter E Oliu, (9th Edition, 2009)

5.8 Semester-VIII

The courses details offered in **SEMESTER-VIII** of BS(Hons) in Computer Science are given below with each description, course outlines, and some latest reference material & books.

5.8.1 INFORMATION SECURITY

Course Code: **CS – 4215** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course provides a survey of both the principles and practice of cryptography and network security. The course covers the importance of securing information in computer systems and their interconnections via networks. Its aim is to provide awareness and in-depth knowledge of various technologies to protect data and resources from disclosure, to guarantee the authenticity of data and messages, and to protect systems from network-based attacks.

COURSE OUTLINES:

Explain and describes foundations of cryptosystems both classical and modern. Describe working of various symmetric ciphers. Explain techniques for ensuring the secrecy and/or authenticity of information. Study of classical cryptosystems and their cryptanalysis techniques. Give examples of various implemented cipher algorithms. State the basic properties selecting and computing secret/shared keys and discussing their constraints. Describe the difference between symmetric and asymmetric ciphers. Explain two most prevalent algorithms, Data Encryption Standard (DES) and Advanced, Encryption Standard (AES). Comprehensively address message authentication and key management. Explain the variants and DES and different modes of operation. Analyze the placement of encryption function and Traffic confidentiality. Explain different key distribution techniques such as public key directory, public key authority and public certificates. To discuss Stream ciphers and explaining with RC4. Explain the core concepts of Public key encryption and Hash functions. Explain the basic concepts of number theory involved in defining public and private keys. Give an in-depth overview on the principles of public key cryptosystems. Explain the RSA algorithms, its working and its security. Discuss the Key management in public key cryptosystems. To describe the mathematical background behind Diffie-Hellman key exchange protocol and its procedural details. To explain CIA and the requirements of authentication. To discuss the various authentication functions used. Describe the Message Authentication Codes and their security. Describe Hash Functions and their collision properties. What is the significance of avalanche effect in hash functions. To explain Digital signature and their significance. Describe various Authentication protocols and Digital Signature Standard. Explain & describe the core

concepts and practical implementation of Network Security Applications to make network components secure. Describe the concept of attacks, threats, vulnerabilities and assets. Discuss the security goals and their significance. To explain the authentication provided by Kerberos. To explain services achieved by X.509 Authentication Service. Discussing the Public-Key Infrastructure and its elements. To discuss the security of Electronic mails. Describe the working and implementation details of Pretty Good Privacy, MIME and S/MIME. To provide an in-depth overview of IP Security, its architecture. Discuss the Authentication Header and Encapsulation of Security Payload. Explain how web security can be provided. How Secure Socket Layer and Transport Layer Security be provided.

REFERENCE BOOKS

1. William Stallings (2005), *Cryptography and Networks Security* (4th Ed), Prentice Hall.
2. Charles P. Pfleeger (2015), *Security in Computing* (5th Ed), Prentice Hall.
3. Raymond Panko (2009), *Corporate Computer and Network Security* (2nd Ed), Prentice Hall.
4. William Stallings (2016), *Network Security Essentials: Applications and Standards* (6th Ed), Pearson.
5. Chris Brenton and Cameron Hunt (1998), *Network Security*, Sybex Inc.
6. Charlie Kaufman, Radia Perlman, and Mike Spencer (2002), *Network Security: Private Communication in a Public World* (2nd Ed), Prentice Hall.
7. Bruce Schneier (1996), *Applied Cryptography: Protocols, Algorithms, and Source Code in C* (2nd Ed), Wiley.

5.9 University Elective Courses

The university elective courses offered are given below with each course outlines and some latest reference material & books.

5.9.1 FINANCIAL ACCOUNTING

Course Code: **CS – 1207** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

COURSE OUTLINES:

Introduction to Accounting and its concepts. Types of organizations and their advantages / disadvantages, Accounting Equation and GAAP, recording of business transactions: Journal, Ledger, Trial Balance. Explain Accounting, the language of Business, its history and need. Concept of Organization and Types of Business Organizations, Concept of transaction and Cash / credit transactions. Advantages and disadvantages of each type of business organizations. Functions of an Accounting System, concept of Accounting Equation, the single / double entry accounting, concept of debit / credit. Detail discussion of GAAP: Generally Accepted Accounting Principles. Recording of Business Transactions: Journal, Ledger and Trial Balance. Explain the concept of business entity, all components of Balance Sheet and Income Statement and completion of Accounting Cycle. Explain in detail the concept of business entity, Assets, Liabilities and Owner's Equity. Describe the types of Financial Statements: Balance Sheet and Income Statement. Explain in detail the components of Balance sheet and method to incorporate the components in Balance Sheet. Explain in detail the components of Income Statements and method to incorporate the components in Income Statement. Completion of Accounting Cycle, Accrual and deferrals. Explain in detail the recording and closing of four types of adjusting entries. Explain the Operation of accounting for Merchandizing Activities. Explain in detail the concept of Inventory. Types of inventory Management: LIFO / FIFO / Average methods. Explain basic manufacturing Asset: Plant and Equipment. Describe the method to record the transactions for acquisition, depreciation and disposal of plant and equipment. Describe different types of depreciation methods. Describe the Corporations and their salient features, Concept of stock-holders equity & its sources, Importance of Earning per share and Dividends.

REFERENCE BOOKS

1. Williams, Meigs and Haka Bettner (2000), *Accounting: the Basis of Business Decisions* (12th Ed), Mcgraw-Hill College.
2. Arif and Afzal, *Accounting an Intuitive Approach* (3rd Ed), Azeem Academy Pub.

5.9.2 Intellectual Property Rights and Cyber Law

Course Code: **CS – 4217** Credit Hours: **3**

Prerequisite: **None**

Course Description

This course covers a selection of topics in the field of Information Technology Law. It will begin by considering the debate about the nature of the influence of information technology upon the development of new legal doctrine, moving on to consider, through topics such as data protection, computer misuse and computer evidence, copyright and digital rights management, criminal content liability and defamation, both how the law has responded to the challenges of information technologies, and the extent to which legal issues have shaped the development of information society policy.

Course Outlines:

Origin and Genesis of IPR. Theories of IPR – Locke's, Hegel and Marxian. Ethical, moral and human rights perspectives of IPR. Intellectual Property Rights: International Relevance. Internationalization of IP protection – Paris Convention, Berne Convention, TRIPS Agreement – basic principles and minimum standards – limits of one-size-fit for all – flexibilities under TRIPS. Intellectual Property Issue Areas. Patent Law, Copyright Law, Trademark Law. Trade Secrets. Technology Transfer. Competition and Antitrust. International Intellectual Property Law. Cyber Law Issue Areas. Criminal Law. Online Privacy. Health Privacy. Freedom of Expression and Human Rights. Regulation of the Internet and Net Neutrality. National Security. Cyber Law and Rights – Obscene Speech. Obscenity & Pornography. Child Abuse Images and Pseudo Images. Age Play. Extreme Pornography. Private Regulation of Pornographic Imagery. Hate Speech, Cyber Law and Rights – Cybercrime Hacking, Viruses & Mail-bombing, Denial of Service. Grooming, Harassment and Cyber-stalking. E-Commerce – Trade Marks and Domain Names. Trade Marks in the Global Business Environment. Trade Mark/Domain Name Disputes. Jurisdiction The use of Trade Marks in Advertising. Re-sellers and Re-importers Sponsored Links. Secondary Markets. E-Commerce – Contracts, Customers Payment. Contracting Informally. Formal Contracts. Electronic Payments. Consumer Protection. Distance Selling. Data Privacy – The Data Protection Act 1998. Digitisation, Personal Data and the Data Industry. Data Protection Act 1998: Background and Structure. Rights and Responsibilities under the Data Protection Act.

Reference Books

1. Benkler (2007), *The Wealth of Networks*, Yale University Pub.
2. Goldsmith and Wu (2008), *Who Controls the Internet* (1st Ed), Oxford University Press.

3. Mayer-Schonberger (2011), *Delete: The Virtue of Forgetting in the Digital Age*, Princeton University Press.
4. Mayer-Schonberger and Cukier (2014), *Big Data: A Revolution That Will Transform How We Live, Work and Think*, John Murray.
5. Murray (2007), *The Regulation of Cyberspace: Control in the Online Environment* (1st Ed), Routledge.
6. Solove (2008), *Future of Reputation*, Yale University Press.
7. Solove (2008), *Understanding Privacy*, Harvard University Press.
8. Zittrain (2008), *The Future of the Internet*, Allan Lane.

5.9.3 ENTREPRENEURSHIP

Course Code:	**CS – xxxx**	Credit Hours:	**3**
Prerequisite:	**None**		

COURSE DESCRIPTION

This course is designed for those interested in starting their own business, either as their primary income or extra income, including individual contributor businesses such as freelancers, contractors, consultants, and others in the gig economy. The curriculum is centered on three key aspects of entrepreneurship: the individual, their traits, skills, and attributes that make entrepreneurs successful, the business ideas, how to generate them, where to look for them, how to expand them, and how to ensure they are valid business ideas with potential to meet profit goals. These elements, developed in the course, will assist any current or potential entrepreneur develop and grow a business now or in the future.

COURSE OUTLINES:

Introduction: The concept of entrepreneurship, The economist view of entrepreneurship, the sociologist view, Behavioural approach, Entrepreneurship and Management. The Practice of Entrepreneurship: The process of entrepreneurship, Entrepreneurial Management, The entrepreneurial business, Entrepreneurship in service institutions, the new venture. Entrepreneurship and Innovation: The innovation concepts, Importance of entrepreneurship, Sources of innovative opportunities, The innovation process, Risks involved in innovation. Developing Entrepreneur: Entrepreneurial profile, Trait approach to understanding entrepreneurship, Factors influencing entrepreneurship, The environment, Socio-cultural factors, Support systems. Entrepreneurship Organization: Team work, Networking organization, Motivation and compensation, Value system. Entrepreneurship and SMES: Defining SMEs, Scope of SMEs, Entrepreneurial, managers of SME, Financial and marketing problems of SMEs. Entrepreneurial Marketing: Framework for developing entrepreneurial marketing, Devising entrepreneurial marketing plan, Entrepreneurial marketing strategies, Product quality and design. Entrepreneurship and Economic Development: Role of entrepreneur in the economic development generation of services, Employment creation and training, Ideas, knowledge and skill development, Case Studies of Successful Entrepreneurs.

REFERENCE BOOKS

1. Paul Burns and Jim Dew Hurst (1989), *Small Business and Entrepreneurship*, Palgrave Macmillan.
2. P. N. Singh (1986), *Developing Entrepreneurship for Economic Growth*, New Delhi: Vikas.

3. Peter F. Drucker (2006), *Innovation and Entrepreneurship*, Harper Business, Reprint edition.
4. John B. Miner (1996), *The 4 Routes to Entrepreneurial Success*, (1st Ed), Berrett-Koehler Publishers.

5.10 Elective Subjects

The elective courses offered are given below with each course outlines and some latest reference material & books.

5.10.1 Introduction to Machine Learning

Course Code: **CS-XXXX** Credit Hours: **3**

Prerequisite:

Course Outlines:

Introduction to machine learning and statistical pattern recognition. Goals and applications of machine learning. Aspects of developing a learning system: training data, concept representation, function approximation. Supervised learning: Naive Bayes, Decision trees for classification & regression for textual, categorical & numerical data, Support vector machines, Neurons and biological motivation. Classification problems in language, Hidden Markov models (HMM's). Use of HMM's for speech recognition, part-of-speech tagging, and information extraction. Perceptrons : representational limitation and gradient descent training. Multilayer networks and backpropagation. Hidden layers and constructing intermediate, distributed representations. Unsupervised learning: K-means, Density Based Clustering Methods (DBSCAN, etc.), EM algorithm. Reinforcement learning; Tuning model complexity; Bias-Variance Tradeoff; Grid Search, Random Search; Evaluation Metrics; Reporting predictive performance.

Reference Books

1. Machine Learning, Tom Mitchell, McGraw Hill (1st Edition, 1997)
2. Applied Machine Learning, online Edition, David Forsyth (1st Edition 2019)
3. Machine Learning: A Probabilistic Perspective, 1st Edition, Kevin R Murphy (2012)
4. Pattern Recognition & Machine Learning by Chris Bishop (1st Edition , 2006)

5.10.2 SOFTWARE QUALITY ASSURANCE

Course Code:	**CS – 4216**	Credit Hours:	**3**
Prerequisite:	**Software Engineering**	**Java Programming Language**	

COURSE DESCRIPTION

The ultimate goal of every Software Project Manager is to complete software project within scheduled time and budget while keeping the number of software defects at minimum level. Software Engineering processes and methodologies generally focus on software delivery time and software cost related concerns. The high quality of software is achieved through set of umbrella activities performed within software development processes and methodologies. Software Quality Assurance comprises of SDLC activities that ensure the software meets functional and non-functional requirements. A successful testing approach for quality assurance can save significant effort and increase product quality, thereby increasing customer satisfaction and lowering maintenance costs. In this SQA course, concepts of software quality, software quality standards, testing strategies, static, behavioral and structural tests generation techniques will be presented in detail. Our focus will be the testing of desktop and Web applications, however testing of Mobile applications will also be discussed. Frameworks and tools will be introduced and used for test automation.

COURSE OUTLINES:

Quality Preliminaries: Concepts; definitions and statements; quality attributes. What is Software Quality? Software Defects? McCall's Software Quality Attributes; ISO Quality Factors, Testing Definitions & Statements; Testing & Debugging Cycle; Misc Concepts. Aligning Testing with the Project Testing in context. Test Process Models, Testing Tactics: Categories of Testing Techniques, Static Testing Reviews: introduction; cost impact of errors; defect amplification; review metrics. Reviews: reference model; types of reviews; review process. Software Testing Strategies, Strategic approach to SW testing; Verification & Validation. Strategy big picture; Strategy steps; Strategic issues. Unit testing, Integration testing: Top-Down and Bottom-Up Approaches, Higher Order Testing , JUnit Test Automation Framework. Automated Testing, XUnit and JUnit Framework, JUnit Framework and Eclipse IDE, Functional (Behavioral) Testing. What is Black-box testing? Equivalence partitioning, Boundary Value Analysis (BVA), Combinatorial Design, Orthogonal Arrays, Structural Testing. What is White-box testing? Basic path testing, Control path testing, Data Flow testing, Integration Testing, Testing of Web Applications. Difference between quality attributes of desktop and Web Applications? Introduction to Selenium-IDE, Quality Standard, ISO, CMMI, People CMM.

REFERENCE BOOKS

1. Rex Black, Pragmatic Software Testing: Becoming an Effective and Efficient Test Professional, John Wiley & Sons 2007
2. Roger S. Pressman, Software Engineering A Practitioner's Approach , Seventh edition, McGraw-Hill, 2010
3. Aditya P. Mathur, Foundations of Software Testing, 2008

5.10.3 DATA MINING

Course Code:	**CS – 3228**	Credit Hours:	**3**
Prerequisite:	**Database Systems**		

COURSE DESCRIPTION

In last few decades, advent of computers and later internet has changed human civilization dramatically. Now we live in the world which is being overloaded with the data and the information. This information overload is posing new challenges to human intellect. The course of Data Mining and Information Retrieval is particularly designed to introduce students with the concepts, tools and techniques of scientific research under this new stage of human evolution and its role in current human society.

COURSE OUTLINES:

Concepts of Data mining, data pre-processing and pre-mining,(noisy and missing data, data normalization and discretization), outlier detection, Data mining learning methods, Data mining classes (Linear regression, classification, association rule mining, clustering), decision trees, rules, patterns and trends.

REFERENCE BOOKS

1. Data Mining: Concepts and Techniques, 3rd Edition Jiawei Han, Micheline Kamber, Jian Pei; 2011.
2. Data Mning: Concepts, Models, Methods, and Algorithms, 2nd Edition, Mehmed Kantatardzic, 2011.
3. Data Mining, Introductory and Advanced Topics, 2006, Margaret H. Dunham and S. Sridhar, Pearson Education.
4. Principles of Data Mining, 2007, Max Bramer, Springer-Verlag.

5.10.4 Image Processing and Computer Vision

Course Code:	**CS – 3222**	Credit Hours:	**3**
Prerequisite:	**Mathematics, Statistics**	**Physics, Data Structure**	
	Programming Language		
	Artificial Intelligence		

Course Description

Digital imaging has emerged as the dominant technology for acquiring and working with images, whether on the web, with a still camera, or video. Here the issues associated with extracting useful information from digital images will be introduced from an artificial intelligence perspective. These include image data structures, preprocessing for noise reduction and feature enhancement, edge detection, segmentation, object recognition. At the end of the course, students should be knowledgeable concerning the major steps and algorithms in the end-to-end computer vision process beginning with image acquisition and ending with a machine-produced perception of the relevant scene. Students should also have a working knowledge of the OpenCV and other computing libraries for image processing.

Course Outlines:

Explain what Image processing, Computer vision. Explain the difference between Image Processing and Computer vision. Motivate students by explaining the association between various discipline of sciences and significance and need of image processing and computer vision in them. Industrial and research oriented Applications overview for Image Processing and Computer vision. Different libraries introduction for computer vision. What is OpenCV. First program for an image. Loading images, displaying images, Input from camera. Explain Elements of Visual perception in which discusses structure of human eye and image formation in human eye then pinhole camera model. Explain Geometric transformations and rotations for 2D and 3D images. Explain pixel transformation and color transformation. Image transformations using OpenCV: Convolution, stretch, shrink, wrap and rotate image. Explain what is convolution and it purpose in image enhancement. Explain Filtering in which discusses linear filtering, one-dimensional two- dimensional Fourier transform, Smoothening: low pass filtering, Gaussian low pass filtering, Blurring: R G B Components, Sharpening: Gaussian high pass filtering. Explain local feature and global feature. Explain feature detectors in which discusses Harris Detector. Explain feature descriptors in which discusses Multiscale Oriented Patches (MOPS), Scale Invariant Feature Transform (SIFT), Maximally Stable Extremal Regions (MSERs). Explain feature matching and tracking.

REFERENCE BOOKS

1. Computer Vision: A Modern Approach by David A. Forsyth and Jeans Ponce
2. Computer Vision: Algorithms and applications by Richard Szeliski
3. Digital Image Processing by Rafael C. Gonzalez and Richard E. Woods

5.10.5 WEB ENGINEERING

Course Code: **CS – 2234** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Provides an introduction to the discipline of Web Engineering and Web Application Development. This course aims to introduce the methods and techniques used in Web-based system development. In contrast to traditional Software Engineering efforts, Web Engineering methods and techniques must incorporate unique aspects of the problem domain such as: document oriented delivery, fine-grained lifecycles, user-centric development, client-server legacy system integration and diverse end user skill levels. This course will also provide basic knowledge on different tools and technologies used in web application development. This course draws upon previous programming and computing experience to develop practical web development and maintenance skills.

COURSE OUTLINES:

Introduction to Web Applications. Categories of web applications. Characteristics of web applications. TCP/IP and other protocols. Quality of web applications. What is HTML and why it is used. Basic syntax of HTML. HTML Forms. Overview of XML and its origins. Syntax of XML. DTD and XSD. What is XHTML. Comparison between HTML and XHTML. Cascading Style Sheets. Overview of CSS and why it is needed. Style rules and style definition. CSS Box Formatting. Different types of selectors in CSS and ancestor descendent model. Element positioning in CSS. Javascript and DOM. What is DOM. Structure of DOM and its basic objects. What is a script and basic constructs in javascript. Functions and arguments in javascript. Classes in javascript. Architecture of Web Applications. Concept of architecture. Different types of architectures. Web based N tier Architecture and MVC. Modeling of Web Applications. Discuss MDA, MDE and MDD. What are modeling dimensions. UML based web engineering. Web Modeling Language. Overview of PHP server side scripting language. Discuss language features. Advanced topics in PHP sessions and cookies. Database connectivity. What is Ajax. Discuss Ajax Architecture.

REFERENCE BOOKS

1. Web Engineering, by Gerti, Birgit, Seigfried, Werner John Wiley & Sons
2. Web Enabled Commercial Application Development, by Ivan Bayross BPB Publications
3. Jonathan Lane, Meitar Moscovitz, Joseph R. Lewis Foundation Website Creation with CSS, XHTML, and JavaScript Apress Company.

5.10.6 NATURAL LANGUAGE PROCESSING

Course Code: **CS – 3224** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This introductory course of Natural Language Processing (NLP) teaches the fundamentals of language processing for machines. NLP focuses on fundamental questions in connection with human languages and Computer Science. This course presents an introduction to natural language computing applications such as information retrieval and extraction, intelligent web searching, speech recognition, and multi-lingual systems including machine translation.

COURSE OUTLINES:

Describe the core concepts and principles of NLP. Explain what NLP, hands on demonstration is. Turing test, Brief history of the field. Explain different NLP tasks in syntax, semantics, and pragmatics. Applications such as information extraction, question answering, and machine translation. Describe the ambiguity problem in language understanding and processing. Describe and discuss ambiguity problem in NLP, Explain Ambiguity and Uncertainty in languages. The Turing test. The problem of ambiguity. The role of machine learning. Describe the Syntactic and Semantic Parsing. Grammar formalisms and treebanks. Efficient parsing for context-free grammars (CFGs). Lexical semantics. Compositional semantics. Semantic Role Labeling and Semantic Parsing. Describe Part of Speech Tagging, Labeling and Hidden Markov Model. Part-of-Speech Tagging, Sequence Labeling and Lexical syntax. Hidden Markov Models. Maximum Entropy Models. Conditional Random Fields. Describe Word Sense Disambiguation. Word Sense Disambiguation, semantic relations and wordnet. Discuss knowledge based, supervised and unsupervised techniques for word sense disambiguation. Describe the core concepts of Information extraction. Named entity recognition and relation extraction. IE using sequence labeling. Describe the core concepts of Machine Translation. Basic issues in MT. Statistical translation. Word alignment, phrase-based translation, and synchronous grammars.

REFERENCE BOOKS

1. Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition, by Daniel Jurafsky and James H. Martin.

5.10.7 Wireless and Mobile Communication

Course Code: **CS – 3211** Credit Hours: **3**

Prerequisite: **Data Communications & Networks**

Course Description

Network Architectures: Wireless Networks ,Cellular networks, Ad hoc networks,Mobile Network Resource Management, Quality of Service, Mobility and Location management, GSM, Mobile-IP; UMTS, 3GPP, Current Mobile Technologies in the world.

Course Outlines:

Overview of Wireless and Mobile Communications. Evolution of Wireless / mobile communications Systems,Advantages/ Disadvantages. Mob Communication in Pakistan. Difference between Wireless and Mobile communication. 2G, 2.5G and 3G , 4 G and beyond 4 G cellular networks. Mobile Communication/Telecommunication standardization organization IMT- 2000. Terrestrial Radio Interfaces, ARIB - Association of Radio Industries and Businesses ,ETSI - European Telecommunications Standards Institute ,TTA - Telecommunications Technology Association, TTC - Telecommunication Technology Committee ,IETF - Internet Engineering Task Force, ITU-R – International Telecommunication Union –Radio communication, ITU-T - International Telecommunication Union - Telecommunication Standardization. GSM- Global System for Mobile Communications. GSM world, Frequencies, Macrocells, Microcells,Picocells, Femtocells, Working of femtocells, Overview of GPRS and EDGE. Architecture of the GSM Network. Components of GSM Architecture. Mobile Station, Base Station Subsystem, Network Subsystem. International Mobile Subscriber Identity (IMSI). GSM- Attach and Detach. Call routing for a mobile terminating call. Call Routing Procedure. Mobile IP. Mobility Issues in IP Networks. Discrepancies of Mobile IP28. Mobile IPv6 (MIPv6). Advances in Mobile IPv6 in Comparison to MIPv4. Route optimization while Roaming in IP network using MIPv6. MIPv6 bi-directional Tunneling mode of operation. UMTS-Universal Mobile Telecommunications system. Universal Mobile Telecommunications systems architecture. UTRAN Components Radio Network Controller (RNC). UMTS Core Network Components. UMTS Network Transaction. Reference Model for UMTS. SIP session Initiation Protocol. Anatomy & Working. LTE – Long Term Evolution.

Reference Books

1. Garg, Wireless Communications and Networks, Morgan Kaufmann 2007, ISBN 978-0-12-373580-5.
2. Kumar, Danjunath and Jury, Wireless Networking, Morgan Kaufmann 2008, ISBN 978-0-12-374254-4.

3. Stallings, Wireless Communications and Networks, Prentice Hall 2002, ISBN 9780131918351.
4. Schwartz, Mobile Wireless Communications, Cambridge University Press, 2005, ISBN 0-521-84347-2.
5. Mark and Zhuang, Wireless Communications and Networking, Prentice Hall 2003, ISBN 0-13-040905-8.

5.10.8 DATA WAREHOUSE AND MINING

Course Code: **CS – 3208** Credit Hours: **3**

Prerequisite: **Database Systems**

COURSE DESCRIPTION

This course will introduce you to the major activities involved in a data warehousing project. The class will begin with an in-depth review of baseline data warehouse principles and concepts. Once the basic principles have been established, the remainder of the class will be built around a group data warehouse project. The project will begin with your group gathering requirements and developing a data warehouse design. Once the design is complete you will build a prototype data warehouse containing the necessary structures within your database and populating them with source data. This will require you to develop the table definitions, extract/transformation/load (ETL) logic, and example report definitions. I intend this class to be a hands-on example of a simple data warehouse implementation.

COURSE OUTLINES:

Understand the desperate need for strategic information. Recognize the information crisis at every enterprise. Distinguish between operational and informational systems. Learn why all past attempts to provide strategic information failed. Clearly see why data warehousing is the viable solution. Review formal definitions of a data warehouse. Discuss the defining features. Distinguish between data warehouses and data marts. Study each component or building block that makes up a data warehouse. Introduce metadata and highlight its significance. Review the essentials of planning for a data warehouse. Distinguish between data warehouse projects and OLTP system projects. Learn how to adapt the life cycle approach for a data warehouse project. Discuss project team organization, roles, and responsibilities.andConsider the warning signs and success factors. Discuss how and why defining requirements is different for a data warehouse. Understand the role of business dimensions. Learn about information packages and their use in defining requirements. Review methods for gathering requirements. Grasp the significance of a formal requirements definition document. Understand data warehouse architecture, Learn about the architectural components, Review the distinguishing characteristics of data warehouse architecture, Examine how the architectural framework supports the flow of data, Comprehend what technical architecture means, Study the functions and services of the architectural components. Clearly understand how the requirements definition determines data design,Introduce dimensional modeling and contrast it with entity-relationship modeling, Review the basics of the STAR schema, Find out what is inside the fact table and inside the dimension tables, Determine the advantages of the STAR schema for data warehouses. Survey broadly all the various aspects of the data extraction, transformation, and loading (ETL) functions, Examine the data extraction function, its challenges, its techniques, and learn how to evaluate and apply the techniques, Discuss the wide range of tasks and types of the data transformation

function, Understand the meaning of data integration and consolidation, Perceive the importance of the data load function and probe the major methods for applying data to the warehouse. Appreciate the enormous information potential of the data warehouse, Carefully note all the users who will use the data warehouse and devise a practical way to classify them, Delve deeply into the types of information delivery mechanisms, Match each class of user to the appropriate information delivery method, Understand the overall information delivery framework and study the component, Gain a true insight into why ETL is crucial, time-consuming, and arduous.

REFERENCE BOOKS

1. Data warehousing fundamentals by PaulrajPunniah, 2nd edition
2. Modern database management by Jeffery A. Hoffer, 11th edition
3. Database Systems: Design, Implementation, and Management By: Peter Rob, Carlos Coronel, 8th edition
4. Fundamentals of database Systems, 6th Edition By: RamezElmasri

5.10.9 COMPUTER GRAPHICS

Course Code:	**CS – 3203**	Credit Hours:	**3**
Prerequisite:	**OOP/Visual Programming**		

COURSE DESCRIPTION

The course on computer graphics introduces the general concepts in this area and this is inculcated through the introduction of various algorithms in computer graphics. These algorithms are implemented through programming languages and techniques of OpenGL. The aim of the course to provide how to draw different standard figures and some fundamental operations on them, and also to introduce animation.

COURSE OUTLINES:

Graphics hardware, Fundamental algorithms, Applications of graphics, Graphics output primitives, Geometric transformations, Two-dimensional viewing, Three-dimensional viewing, Three-dimensional object representations, Two and three dimensional imaging geometry (Perspective projection and Orthogonal projection) and transformations, Mathematics for computer graphics, Ray Tracing, Shading, Rasterization, Discrete Techniques.

REFERENCE BOOKS

1. Fundamentals of Computer Graphics: 2nd Edition by Peter Shirley A. K. Peters, 2005.
2. Computer Graphics, Principles and Practice, J. D. Foley, A. van Dam, S. K. Feiner and J. F. Hughes, Addison-Wesley ISBN: 0-201-12110-7.
3. Computer Graphics, F. S. Hill, Maxwell MacMillan ISBN: 0-02-354860-6.
4. Computer Graphics with OpenGL, 3rd Edition, Prentice Hall 2009.

5.10.10 DIGITAL SIGNAL PROCESSING

Course Code: **CS – 3210** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course aims to develop mathematical and analytical skills necessary to analyze digital signals both in time and frequency domains. From the system's perspective, the objective is to incorporate extensive design skills in the students enabling them to develop relevant prototypes with the desired level of accuracy.

COURSE OUTLINES:

Overview of Discrete-time systems. Application of z-transform for analysis of Linear Shift Invariant systems, Circular Convolution, Discrete Fourier Transform, Fast fourier Transform, Butterworth and Chebyshev approximation of analogue filters, Finite Impulse Response (FIR) and Infinite Impulse Response (IIR) filters, Design of FIR filter, Design of IIR Filter.

REFERENCE BOOKS

1. Digital Signal Processing - Principles, Algorithms and Applications, 4th Edition, by John G. Proakis and Dimitris K. Manolakis, Prentice Hall.
2. Digital Signal Processing - A computer Based Approach by Sanjit K. Mitra, McGraw Hill, 2nd Edition.
3. Discrete-Time Signal Processing by A. V. Oppenheim and R. W. Schaffer, 3rd Edition, Prentice Hall.
4. Digital Signal Processing - A Modern Introduction by A. Ambardar, Thomson.
5. Fundamentals of Digital Signal Processing Using MATLAB by R. J. Schilling and S. L. Harris, Thomson.

5.10.11 EMBEDDED SYSTEM

Course Code:	**CS – 3213**	Credit Hours:	**3**
Prerequisite:	**Digital Logic Design**		

COURSE DESCRIPTION

To acquaint the students with the organization, programming and applications of microprocessor-based systems.

COURSE OUTLINES:

This course will cover the basics of embedded system organization, system on programmable-chip technologies and real-time systems. It provides the advance knowledge required for embedded computer design and development as well as real-time operating systems. Students are introduced to software development concepts applicable to real-time and embedded systems. Particularly ARM Cortex M3 will be studied as a representative embedded processor and embedded software development is carried out for ARM Cortex CPUs. The students will be able to grasp the main principles of embedded system design and understand the concept of hardware-software codesign, system on programmable chip (SoPC), real-time operating systems and scheduling techniques. Embedded system co-specification and partitioning is also introduced in the course. SystemC or other languages (e.g. UML, C, etc.) can be employed to present a unified view of the embedded systems. Embedded hardware-software design and development tools (such as Altera Quartus II and SOPC builder) will be introduced.

REFERENCE BOOKS

1. Daniel W. Lewis, Fundamental of Embedded Software with the ARM Cortex M3, Pearson 2013, ISBN 978-0-13-291654-7.
2. Computer as Components: Principles of Embedded Computing System Design, M. Wolf, Morgan Kaufman Publishers 2013, ISBN 978-0-12-374397-8.
3. Embedded Core Design with FPGAs , Z. Navabi, McGraw Hill 2007, ISBN 978-0-07-147481-8.
4. Real-time Systems and Programming Languages , Alan Burns and Andy Wellings, Addison-Wesley 2001, ISBN 0 201 72988 1.

5.10.12 DIGITAL IMAGE PROCESSING

Course Code: **CS – 3209** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

Since 1964 the advent of large-scale digital computers and the space program have made digital image processing one of the most rapidly growing fields in electrical engineering. Now image processing has found much more wide applications not only in the space program, but also in the areas such as medicine, biology, industrial automation , astronomy, law enforcement, defense, intelligence. With the progress made in multimedia these days, digital image processing finds more wide applications. It has become an indispensable part of our digital age.

COURSE OUTLINES:

Introduction: Elements of digital image processing, Image model, Sampling and quantization, Relationships between pixels, Image Enhancement: Enhancement by point processing, Spatial filtering, Enhancement in the frequency domain, Colour Image Processing, image Segmentation: Discontinuity detection, Edge linking and boundary detection, Thresh holding, Region oriented segmentation, Use of motion for segmentation, Image Registration: Introduction to image registration, Techniques of image registration, Representation and Description: Boundary description, Regional description, Morphological Image Processing: Dilation and Erosion, Opening and Closing, Some basic morphological algorithms, Extensions to gray level images, Image Transforms: Discrete Fourier Transform, Discrete Cosine Transform, Haar Transform, Hadamard Transform.

REFERENCE BOOKS

1. Digital Image Processing, R. C. Gonzalez & R. E. Woods, 3rd edition, Prentice Hall, 2008, ISBN 9780131687288.
2. Digital Image Processing (3rd Edition) by Rafael C. Gonzalez, Prentice Hall; 2007.
3. Understanding Digital Signal Processing (3rd Edition) by Richard G. Lyons, Prentice Hall; 2010.

5.10.13 SOFTWARE AGENTS

Course Code: **CS – 3213** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

To acquaint the students with the organization, programming and applications of microprocessor-based systems. An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through effectors. A human agent has eyes, ears, and other organs for sensors, and hands, legs, mouth, and other body parts for effectors. A robotic agent substitutes cameras and infrared range finders for the sensors and various motors for the effectors. A software agent has encoded bit strings as its percepts and actions.

COURSE OUTLINES:

Basics of Intelligent Agents. Intelligent Agents Application. Desktop Agents. Internet Agents. Web search Agents, Information Filtering Agents, Personalized Newspaper, Offline Delivery Agents, URL-minder, Bargain Finder. Intranet Agents. Mobile Agents. Technology of Intelligent Agents. Agent Machinery. Agent Content. Agent Access. Agent Security. Developing Agent Applications.

REFERENCE BOOKS

1. Daniel W. Lewis, Fundamental of Embedded Software with the ARM Cortex M3, Pearson 2013, ISBN 978-0-13-291654-7.
2. Computer as Components: Principles of Embedded Computing System Design, M. Wolf, Morgan Kaufman Publishers 2013, ISBN 978-0-12-374397-8.
3. Embedded Core Design with FPGAs , Z. Navabi, McGraw Hill 2007, ISBN 978-0-07-147481-8.
4. Real-time Systems and Programming Languages , Alan Burns and Andy Wellings, Addison-Wesley 2001, ISBN 0 201 72988 1.

5.10.14 SEMANTIC WEB

Course Code: **CS – 3215** Credit Hours: **3**

Prerequisite: **None**

COURSE DESCRIPTION

This course introduces the core concepts of the Semantic Web that promises to dramatically improve the current World Wide Web (WWW) and its use. The Semantic Web technology aims at removing main obstacles which prevent Web users from better support because the meaning of Web content is not machine-accessible. The key idea of the Semantic Web is the use of machine-processable Web information. Its key technologies include explicit metadata, ontologies, logic and inferencing, and intelligent agents. The Semantic Web will gradually evolve out of the existing Web. Huge potential and advantages of the Semantic Web technology have driven heavy investment from industry and governments.

COURSE OUTLINES:

This course is designed to explain the features, rationale, and advantages of Semantic Web technology. Describe the XML (Extensible Markup Language) language structure and XML document model. Explain how to validate XML documents using DTDs (Document Type Definitions) and XML Schema. Explain the concepts of graph-based RDF model, XML syntax-based RDF model, and RDF Schema. Use Java APIs to parse XML document and manipulate XML data. Analyze the requirements and features of web ontology language (OWL). Define properties and property restrictions, and Boolean combinations of the OWL classes. Build and analyze ontologies using an ontology editor. Use Java API to manipulate RDF data model and ontology. Describe the syntax and semantics of Horn logic and nonmonotonic rules in XML-like languages. Describe rule-based reasoner to implement both RDFS and OWL reasoners. Analyze application cases in data integration, data exchange, knowledge management, e-learning, and web services. Discuss the methodologies in ontology engineering and research issues in Semantic Web technology.

REFERENCE BOOKS

1. Grigoris Antoniou and Frank van Harmelen, A Semantic Web Primer, 2nd Edition, 2012 The Massachusetts Institute of Technology Press, ISBN: 978-0-262-01242-3.
2. Tom Heath and Christian Bizer. Linked Data: Evolving the Web into a Global Data Space (Synthesis Lectures on the Semantic Web, Theory and Technology. 2011.
3. Toby Segaran, Colin Evans and Jamie Taylor. Programming the Semantic Web. O'Reilly, 2009.
4. Dean Allemang, Jim Hendle. Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL, 2nd ed. Morgan Kaufmann/Elsevier 2011.

5.10.15 Software Development Process

Course Code:	**CS – 3223**	Credit Hours:	**3**
Prerequisite:	**Basic programming language**		

Course Description

This course provides an in-depth study of the process of developing software systems, including the use of software processes in actual product development, techniques used to ensure quality of the software products and maintenance tasks performed as software evolves. By the end of the course, students will understand the role of software processes in the development of software and will have experienced several types of processes, from rigid to agile. Students will also become familiar with a variety of modern technologies and development techniques and understand their connection to software processes.

Course Outlines:

Introduction and Overview, Life Cycle Models, Integrated Development Environment, Version Control Systems, Requirements Engineering, Object Oriented Software and UML, Software Architecture, A Tale of Analysis and Design, Design Patterns, Unified Software Process, General Concepts, Black-Box Testing, White-Box Testing, Agile Development Methods, Software Refactoring.

Reference Books

1. Armando Fox and David Patterson, Engineering Software as a Service, 2013.
2. Matt Wynne and Aslak Hellesoy, The Cucumber Book, 2012.
3. Eddie Burris, Programming in the Large with Design Patterns, 2012.
4. Martin Fowler,Refactoring, 2000.

5.10.16 ADVANCED SOFTWARE ENGINEERING

Course Code:	**CS – 3207**	Credit Hours:	**3**
Prerequisite:	**Software Engineering**		

COURSE DESCRIPTION

This course aims to introduce the principles and techniques of validating and verifying software systems at an intellectually demanding level. It will cover not only the state-of-the practice in validation and verification, but also the most significant trends, problems and results in validation and verification research.

COURSE OUTLINES:

The students should be able to understand the use of logic as a formal language for the specification of systems, to understand the use of the main verification techniques used in symbolic model checking, and be able to verify simple systems. In addition, students should have a good understanding of the range of approaches to testing that can be applied to software systems and be able to undertake code level unit testing. Further, successful students will be able to appreciate the limitations of the current tools and have insights in ongoing research topics to overcome them.

REFERENCE BOOKS

1. Ian Sommerville. Software Engineering, Addison-Wesley, 10th edition, 2015.
2. Software Engineering: A Practioner's Approach, Roger Pressman, McGraw-Hill, 8th Edition, 2014.

5.10.17 SOFTWARE MODEL CHECKING

[1]

Course Code:	**CS-4114**	Credit Hours:	**3**
Prerequisite:	**Nil**		

COURSE OUTLINES:

Introduction to Program testing; static analysis; deductive techniques; model checking; Transition systems, safety, liveness and fairness properties, Omega-regular automata. Temporal logics LTL, CTL and CTL*, and their model-checking algorithms. State-space explosion problem, timed automata and probabilistic automata and their model checking. Bounded model checking; Programs as first-order formulas. The SPIN, and NuSMV Model Checkers.

REFERENCE BOOKS

1. Edmund M. Clarke, Orna Grumberg and Doron Peled, Model Checking, 2nd Edition, MIT Press, 2018.
2. Christel Baier and Joost-Pieter Katoen, Principles of Model Checking, MIT Press, 2008.
3. Michael Huth and Mark Dermot Ryan, Logic in Computer Science Modelling and Reasoning about Systems, 2nd Edition, Cambridge University Press, 2004.
4. Ronald Fagin, Joseph Y. Halpern, Yoram Moses, and Moshe Vardi, Reasoning About Knowledge, MIT Press London, 2004.

[1] **63rd Meeting of Syndicate held on 10-08-20 Notification No. REG/ACAD-23/20 dated 17-08-21 & in 23rd Academic Council Meeting**

5.10.18 DATA WAREHOUSE

Course Code:	**CS – 3227**	Credit Hours:	**3**
Prerequisite:	**Database Systems**		

COURSE DESCRIPTION

This course will introduce you to the major activities involved in a data warehousing project. The class will begin with an in-depth review of baseline data warehouse principles and concepts. Once the basic principles have been established, the remainder of the class will be built around a group data warehouse project. The project will begin with your group gathering requirements and developing a data warehouse design. Once the design is complete you will build a prototype data warehouse containing the necessary structures within your database and populating them with source data. This will require you to develop the table definitions, extract/transformation/load (ETL) logic, and example report definitions. I intend this class to be a hands-on example of a simple data warehouse implementation.

COURSE OUTLINES:

Understand the desperate need for strategic information. Recognize the information crisis at every enterprise. Distinguish between operational and informational systems. Review formal definitions of a data warehouse. Discuss the defining features. Distinguish between data warehouses and data marts. Introduce metadata and highlight its significance. Distinguish between data warehouse projects and OLTP system projects. Discuss project team organization, roles, and responsibilities. Discuss how and why defining requirements is different for a data warehouse. Understand the role of business dimensions. Learn about information packages and their use in defining requirements. Review methods for gathering requirements. Grasp the significance of a formal requirements definition document. Understand data warehouse architecture, Learn about the architectural components, Review the distinguishing characteristics of data warehouse architecture, Examine how the architectural framework supports the flow of data, Comprehend what technical architecture means, Study the functions and services of the architectural components. Clearly understand how the requirements definition determines data design, Introduce dimensional modeling and contrast it with entity-relationship modeling, Review the basics of the STAR schema, Find out what is inside the fact table and inside the dimension tables, Determine the advantages of the STAR schema for data warehouses. Survey broadly all the various aspects of the data extraction, transformation, and loading (ETL) functions, Examine the data extraction function, its challenges, its techniques, and learn how to evaluate and apply the techniques. Appreciate the enormous information potential of the data warehouse, Carefully note all the users who will use the data warehouse and devise a practical way to classify them.

REFERENCE BOOKS

1. Data warehousing fundamentals by Paulraj Punniah.
2. Modern database management by Jeffery A. Hoffer.
3. The Data Warehousing Life Cycle Toolkit by Ralph Kimball.
4. Case study book: The Data Warehousing Toolkit by Ralph Kimball.
5. C. Imhoff et al., Mastering Data Warehouse Design: Relational and Dimensional Techniques, Wiley, 2003.

5.10.19 GRAPH THEORY

Course Code:	**CS – 4102**	Credit Hours:	**3**
Prerequisite:	**Discrete Structures**		

COURSE DESCRIPTION

This course will provide the key concepts of Discrete Structures such as Sets, Permutations, Relations, Graphs, and Trees etc. Formal logic proofs and/or informal, but rigorous, logical reasoning to real problems, such as predicting the behavior of software or solving problems such as puzzles. Apply discrete structures into other computing problems such as formal specification, verification, databases, artificial intelligence, and cryptography. Differentiate various discrete structures and their relevance within the context of computer science, in the areas of data structures and algorithms, in particular.

COURSE OUTLINES:

Introduction to Graph Theory, Basic definitions, computer representations and properties of Graph, Data structure for representing Graphs, Fundamental theorem of Graph Theory, Isomorphic and Special Graphs, Properties of Trees and Forests, Binary tree, Balanced binary tree, Directed and Undirected rooted tree, Minimum Spanning Tree algorithms and implementation, Path and Distance in graphs, Shortest path algorithms and implementation, Cycle and distance in weighted graph and digraphs, Distance algorithms and implementation, Eulerian graphs and Hamiltonians graphs with applications, Flow networks, Max-flow Min-cut Theorem, Graph coloring, Edge coloring, Planar graphs, Four color theorem, Deadlock of computer system, Matching Algorithms, Dominance & Ramsey theory.

REFERENCE BOOKS

1. Graph Theory & Applications (1st Edition) by Fournier. Published by Wiley-ISTE, 2011.
2. Applied Algorithmic Graph Theory (1st Edition) by Chartrand. Published byMcGraw-Hill College, 1995.
3. Handbook of Graph Theory (Series Edition) by Jonathan Published by CRC Press, 2004.
4. Graph Theory with Applications (8th Edition) by J. A. Bondy, Published Elsevier USA, 1982.

5.10.20 Introduction to Computer Vision

Course Code: **CS – 4218** Credit Hours: **3**

Prerequisite: **None**

Course Description

This course will provide the key concepts of computer vision in general for different applications, etc. Understand and implement camera calibration, Working under OpenCV or Matlab computer vision toolbox, etc. Implementation of an algorithm to assemble the extracted features to develop a higher-level perception, Implementation of different algorithms for spatial and frequency domain filtering, feature detection, structure from motion, motion estimation, etc. Developing an algorithm for context awareness or scene understanding.

Course Outlines:

Introduction, Image formation, Spatial and frequency domain processing, Feature detection and extraction, Image registration, Segmentation, Camera calibration, Structure from motion, Motion estimation, Stereo vision, Object detection and recognition, Object tracking, 3D scene reconstruction, Context and scene understanding, Image stitching, Image-based and video-based rendering, High-performance computing paradigms for vision and image processing.

Reference Books

1. Computer Vision - A Modern Approach, by D. Forsyth and J. Ponce, Prentice Hall, 2003.
2. Szeliski R., Computer Vision - Algorithms and Applications, Springer, 2011.
3. J. R. Parker, Algorithms for Image Processing and Computer Vision, Willey Publishing Inc. 2011.
4. Gonzalez R. C., Woods R. E., Digital Image Processing, Pearson Education, 3rd edition, 2008

5.10.21 PARALLEL & DISTRIBUTED COMPUTING

Course Code: **CS – 3216** Credit Hours: **3**

Prerequisite: **Data Communications & Networks**

COURSE DESCRIPTION

This course covers general introductory concepts in the design and implementation of parallel and distributed systems, covering all the major branches such as Cloud Computing, Grid Computing, Cluster Computing, Supercomputing, and Many-core Computing. The specific topics that this course will cover are: asynchronous/synchronous computation/communication, concurrency control, fault tolerance, GPU architecture and programming, heterogeneity, interconnection topologies, load balancing, memory consistency model, memory hierarchies, Message passing interface (MPI), MIMD/SIMD, multithreaded programming, parallel algorithms & architectures, parallel I/O, performance analysis and tuning, power, programming models (data parallel, task parallel, process-centric, shared/distributed memory), scalability and performance studies, scheduling, storage systems, and synchronization.

COURSE OUTLINES:

Why use parallel and distributed systems? Why not use them? Speedup and Amdahl's Law, Hardware architectures: multiprocessors (shared memory), networks of workstations (distributed memory), clusters (latest variation). Software architectures: threads and shared memory, processes and message passing, distributed shared memory (DSM), distributed shared data (DSD). Possible research and project topics, Parallel Algorithms, Concurrency and synchronization, Data and work partitioning, Common parallelization strategies, Granularity, Load balancing, Examples: parallel search, parallel sorting, etc. Shared-Memory Programming: Threads, Pthreads, Locks and semaphores, Distributed-Memory Programming: Message Passing, MPI, PVM. Other Parallel Programming Systems, Distributed shared memory, Aurora: Scoped behaviour and abstract data types, Enterprise: Process templates. Research Topics.

REFERENCE BOOKS

1. B. Wilkinson and M. Allen, Parallel Programming: Techniques and Applications Using Networked Workstations and Parallel Computers, 1/e, Prentice Hall, 1999.
2. W. Stevens, Advanced Programming in the Unix Environment, Addison Wesley, 1993.

6. Examination Rules & Regulations[1]

6.1 Preliminary

In exercise of the powers conferred upon it by section 23 sub section 2(VII) read with section 27 sub section V of the Government College University Lahore Ordinance 2002 (Ordinance XLVIII of 2002) the Syndicate of the GC University Lahore is pleased to make the following Regulations:-

6.2 Short Title and Commencement

These Regulations shall come into force with immediate effect.

6.2.1 GENERAL REGULATIONS

These Regulations shall be applicable to all the academic programs of GC University Lahore.

6.2.2 DEFINITIONS

In these Regulations, unless the context otherwise requires, the following expressions shall have the meaning hereby respectively assigned to them; that is to say:

1. **Controller**:
   means the Controller of Examinations, GC University Lahore.

[1]Examination Rules are very briefly enlisted the detail/modified (if any) rules & regulations may be obtained from the Controller of Examination. These are the important/relivant rules information. Furthermore, errors and omissions are expected.

2. **DEPARTMENT**:
   means the concerned Department of GC University Lahore.
3. **STUDENT**:
   means the student of GC University Lahore.
4. **ACADEMIC YEAR**:
   means the period of year during which the students attend University. It includes a fall and spring semester, with a shorter optional summer semester.
5. **ASRB**:
   means Advanced Studies and Research Board.
6. **BOS**:
   means Board of Studies for a respective department.
7. **COURSE**:
   means teaching unit of a discipline to be covered within a Semester as detailed in the Curriculum of study program and issued by the University. Each course is identified by a Course Code, Course Title and Credit Hours.
8. **COURSE INSTRUCTOR**
   means a teacher who taught a particular course to the students.
9. **CREDIT HOURS**
   means weight assigned to a course in term of teaching time.
10. **CURRICULUM**
    means set of courses, course work and their contents offered for a particular program. It includes course objectives, the contents and methods that will be used to teach.
11. **CGPA**
    means Cumulative Grade Point Average.
12. **DEPARTMENT**
    means the concerned Department of GC University Lahore.
13. **DEPARTMENTAL CONTROLLER OF EXAMINATIONS**
    means person responsible for all matters of Examinations at departmental level. He/she shall be nominated by the Chairperson/ Director of respective department.
14. **DEGREE**
    means a title awarded to a student, under seal of Government College University Lahore, at the end of any program in recognition of satisfactory completion of prescribed courses of study for the particular program.
15. **EXAMINER**
    means a person who sets and marks examination to test student's knowledge or proficiency.
16. **EXTRAORDINARY CIRCUMSTANCES**
    means unusual situation, which is not covered under normal regulations.

17. **GRADE**
means letter grade awarded to student in each course, as per prescribed formula, on the basis of marks obtained by the student and his/her relative position in the class in the respective course.

18. **GRADUATE**
means a student who has successfully completed the course of study and has been awarded the degree.

19. **GPA**
means Grade Point Average.

20. **MARKS**
means original marks obtained by the student.

21. **MAKE-UP TEST**
means test given to the students who have remained absent in the Internal Tests as mentioned in different Programs.

22. **ORIC**
means Office of Research, Innovation and Commercialization.

23. **PLAGIARISM**
means taking and using thoughts, writings and inventions of another person as one's own. Plagiarism is the violation of ethical norms or academic or intellectual dishonesty.

24. **PROBATION**
means a status granted to a student whose academic performance falls below an acceptable standard.

25. **PROGRAM**
means a broad area of study for specific types of degree paths over a specific period of time.

26. **PROGRESS REPORT**
means a semester wise distributed inventory of courses taken and grades earned by a student. It will be issued after each semester.

27. **REPEAT COURSE**
means to study the course again.

28. **SEMESTER**
means a period of 16-18 weeks duration, during which University will hold classes.

29. **STUDENT**
means the student of GC University Lahore.

30. **TRANSCRIPT**
means an inventory of courses taken and grades earned by a student throughout the whole program. It will be issued at the end of program.

31. **UNFAIR MEANS CASES COMMITTEE**
means Discipline Committee for Examination.

6.3 STATUS OF A STUDENT

1. A student admitted to any program in GC University Lahore shall be a full time student, enrolled for on-campus studies.

2. No student shall get admission in another course of study in this University or any other Institution during his/her enrollment as a student of any program of GC University Lahore.

3. No student shall accept any employment or work in any organization (private or public) during his/her enrollment as a bona fide student of this University. However this condition shall not apply to the students admitted in self-supporting / evening programs. Such students shall have to submit a ”No Objection Certificate” from their employer

6.4 Code of Conduct of Examination

1. All Tests and Final Examinations shall take place on the University Campus.

2. The medium of instructions and examination in GC University Lahore shall be English.

3. The Quizzes/ Assignments/ Projects and Mid-Term Examination given to the students by their respective teachers shall be called SEMESTER WORK, while the examination at the end of the Semester shall be called FINAL EXAMINATION.

4. No student shall be allowed to leave the examination center before the half time is over. If he/ she leaves, he/ she should handover the question paper and answer script to the invigilator of Examination Centre.

5. No student shall be allowed to sit in the examination center without University or Computerized National Identity Card (CNIC).

6. No student shall be admitted in the examination center half an hour after the commencement of the exam.

6.5 Indiscipline in Examination

1. **Any student who**
   (a) Commits impersonation in the exam
   (b) Copy from any paper, book, notes, or electronic device or possess any such thing
   (c) Mutilates the answer script

(d) Misbehave, create disturbance or refuses to obey the examination staff

2. **Shall take any of the following disciplinary actions**
   (a) Cancellation of paper
   (b) Suspension from program for 1 semester
   (c) Fine of minimum Rs. 5000/-
   (d) Expulsion forever from university

6.6 Grading System

The result of Theory / Practical Courses shall be calculated on Relative Scale and the result of Final Year Project shall be calculated on Absolute Scale.

LETTER GRADE	NUMERIC VALUE OF GRADES	DESCRIPTION
A^+	4.0	Outstanding
A	3.7	Excellent
B^+	3.3	Very Good
B	3.0	Good
B^-	2.7	Average
C^+	2.3	Satisfactory
C	2.0	Pass
C^-	1.7	Low Pass
D	1.0	Barely Pass
F	0.0	Fail
In	—	Incomplete

6.6.1 Grade Point (GP)

$$\text{Grade Point} = \text{Numeric Value of Grade} \times \text{Credit Hours}$$

$$\text{GP} = (\text{Numeric Value of Grade} \times \text{CH})$$

6.6.2 Grade Point Average (GPA)

Performance in any semester is reported in Grade Point Average. This is the average of weighted grade points earned in the courses taken during the semester. The Grade Point Average is obtained by dividing the sum of Grade Points attained in each course by the total number of Credit hours for that semester.

$$GPA = \frac{Sum\ of\ Grade\ Points\ earned}{Sum\ of\ Credit\ Hours\ earned}$$

$$OR$$

$$GPA = \frac{\sum GP_x}{\sum CH_x}$$

$(x = 1 \rightarrow n,\ n$ is the number of courses in a semester)

6.6.3 Cumulative Grade Point Average (CGPA)

Cumulative Grade Point Average is the up-to-date mean of the Grade Points earned by the student in a Program of study. It is an indication of student's overall performance at any point in the program. It is calculated by dividing the total of Grade Points attained by the student in all semesters by the total number of credit hours for all the semesters.

$$CGPA = \frac{Sum\ of\ Grade\ Points\ earned\ during\ the\ program}{Sum\ of\ Credit\ Hours\ earned\ during\ the\ program}$$

$$OR$$

$$CGPA = \frac{\sum GP_z}{\sum CH_z}$$

$(z = 1 \rightarrow m,\ m$ is the number of total courses studied by the student in all semester)

6.6.4 Credit Hours (CH)

Credit hours are weights assigned to a course. The distribution is as follows:

1. **THEORY:**
   One credit is equivalent to One hour of class for course of theory per week throughout the semester.
2. **PRACTICAL/LAB:**
   One credit is equivalent to Two to Three hour of Laboratory work (as per requirement of the particular department) per week throughout the semester.
3. **CLINICAL:**
   One credit is equivalent to Three hour of Clinical Work per week throughout the semester.
4. **RESEARCH:**
   One credit is equivalent to Three hour of Research Work per week throughout the semester.

6.7 Semester Freeze

1. Semester Freeze for Semester-I of any program shall not be allowed.
2. The application for Semester Freeze should be submitted by the student within TWO weeks from the start of the Semester. No application for Semester Freeze shall be entertained after this period.
3. A Student may apply for freeze at the most Two semesters, subject to the maximum length of the program.

6.8 Program Breakup

1. The BS(Hons.) in Computer Science program is divided into four academic years and each academic year is divided into Two Semesters.

YEAR-I	YEAR-II	YEAR-III	YEAR-IV
Semester-I	Semester-III	Semester-V	Semester-VII
Semester-II	Semester-IV	Semester-VI	Semester-VIII

2. **Each semester shall be of**
   (a) 18 weeks duration
   (b) comprising of 16 weeks for teaching
   (c) 02 weeks of Tests and Examinations.
3. The **MAXIMUM DURATION** allowed to a student for the completion of Hons. Degree is **SIX YEARS**. In exceptional cases, an extension of 1 year may be granted.
4. The Course Load allowed for a Regular Student shall be 15-19 credit hours in a Regular Semester.
5. In case of repeating failed/ dropped/ improve course, a student can take maximum One extra course of upto 04 credit hours during regular semester.
6. The students shall be required to get registered for any repeat course within one week of the start of Semester. No student shall be allowed to add/drop any course after the end of second week of semester.

6.9 Assessment Criteria

Separate Practical Paper of 50 Marks each shall be given to students in courses where practical are involved.

I	SEMESTER WORK	
	Mid Semester Test	20 Marks
	Quiz/Assignments/Presentation	30 marks
II	FINAL EXAMINATION	50 marks
	TOTAL	100 MARKS

6.9.1 Mid Semester Exam

1. Mid semester test shall be conducted during 9th week of the semester.
2. A student has to appear in the mid semester test of each course in a semester failing which ”F” grade shall be awarded in that course.

6.10 Attendance Criteria

1. A student must attend at least 80% of the lectures delivered in each course in a semester to be eligible to appear in the Final Examination of that course.
2. In case a student is involved in University Level Society/ Sports and is participating in any such event, he/she may be allowed to appear in the Final Examination of course/s in which he/she has attended at least 60% of the lectures delivered in the class.
3. A student, who is declared Not Eligible by the Chairperson of the department for the Final Examination of any course(s), shall be awarded "In" (Incomplete) grade in such course(s).

6.11 Criteria for Qualifying a Semester

1. In case a student does not complete the Semester Work and/or does not appear in the Final Examination of a course he/she shall be awarded an ”F” grade in that course.
2. A student shall pass a course if he/ she scores at least 50% marks in the Semester Work and Final Examination separately.
3. No grace marks shall be awarded to the students.
4. A student, who fails to score a minimum of 1.50 CGPA at the end of any semester, shall have to get Re-admission in the Program i.e, First Semester.

5. A student who scores CGPA between 1.50 and 2.00 at the end of any semester; shall be placed on First Probation. Such student shall be conditionally promoted to the next semester.

6. In case a student fails to score 2.00 CGPA in the Semester of First Probation, another chance shall be given to such student. He/ she shall be conditionally promoted to the next Semester and shall be placed on Last Probation.

7. In case a student fails to score 2.00 CGPA in the semester of Last Probation he/ she shall have to get Re-admission in the Program.
   Re-admission in Program is only allowed once.

8. A student who gets re-admission in the program shall get exemption for the course(s) which he/ she has qualified with grade equal to or higher than ”C+”.

9. A student shall be given Only One chance to pass the ”F” Grade of a course. In case he/ she fails to qualify the course, he/ she shall have to get Re-admission in the Program.

10. A student can be given only one chance to improve a course with grade less than B-.

11. A student, who remains absent or fails to qualify all the courses of a semester, shall not be allowed to continue in the next semester.

6.12 Degree Requirements

1. A student has to complete 130-140 credit hours study, out of which 06 Credit Hours are of Final Year Project, subject to the passing of all the courses, for the completion of Degree.

2. He/ she has to score at least 2.30 CGPA at the end of program for the award of Degree.

3. In case a student does not have 2.30 CGPA at the end of Semester-VIII, he/ she may be allowed to Repeat one or more courses, in which his/her Grade is below ”B-”

Index