Curriculum

of

BS Computer Science with following Specializations

(Artificial Intelligence, Cyber Security, Data Science, Multimedia and Gaming)

Revised as per HEC Curriculum 2023
(Jan 08, 2024)

Department of Computer Science
University of Engineering and Technology, Lahore, Pakistan

Table of Contents

Program Educational Objectives (PEOs)

- **PEO1 – Computing Education and Application**
  Graduates demonstrate theoretical and practical knowledge and skills of computer science to solve real-world complex problems.

- **PEO2 - Professionalism, Leadership, Continuous Learning**
  Graduates demonstrate professionalism, leadership qualities and engage in continuous learning of new developments in diverse fields of computing.

- **PEO3 - Teamwork, Communication, Ethics**
  Graduates communicate effectively work in a multidisciplinary team environment and exhibit an awareness of the professional and social responsibility by making an impact on the society in an ethical manner.

Program Learning Outcomes (PLOs)

1. Knowledge for Solving Computing Problems
Apply knowledge of computing fundamentals, knowledge of a computing specialization, and mathematics, science, and domain knowledge appropriate for the computing specialization to the abstraction and conceptualization of computing models from defined problems and requirements.

2. Problem Analysis
Identify, formulate, research literature, and solve complex computing problems reaching substantiated conclusions using fundamental principles of mathematics, computing sciences, and relevant domain disciplines.

3. Design/ Development of Solutions
Design and evaluate solutions for complex computing problems, and design and evaluate systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

4. Modern Tool Usage
Create, select, adapt, and apply appropriate techniques, resources, and modern computing tools to complex computing activities, with an understanding of the limitations.

5. Project Management
An ability to demonstrate management skills and apply computing principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

6. Individual and Teamwork
Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.

7. Communication
Communicate effectively with the computing community and with society at large about complex computing activities by being able to comprehend and write effective reports, design documentation, make effective presentations, and give and understand clear instructions.

8. Computing Professionalism and Society
Understand and assess societal, health, safety, legal, and cultural issues within local and global contexts, and the consequential responsibilities relevant to professional computing practice.

9. Ethics
Understand and commit to professional ethics, responsibilities, and norms of professional computing practice.

10. Life-long Learning
Recognize the need, and have the ability, to engage in independent learning for continual development as a computing professional.

PEOs to PLOs Mapping

(PLOs)	PEO1: Computing Education & Application	PEO2: Professionalism, Leadership, Continuous Learning	PEO3: Teamwork, Communication, Ethics
1. Knowledge for Solving Computing Problems	✓		
2. Problem Analysis	✓		
3. Design/ Development of Solutions	✓		
4. Modern Tool Usage	✓		
5. Project Management			✓
6. Individual and Teamwork			✓
7. Communication			✓
8. Computing Professionalism and Society		✓	
9. Ethics			✓
10. Life-Long Learning		✓	

Revised Curriculum for BS Computer Science
(Session 2023 onwards)

Knowledge Area-wise Comparison of NCEAC and UET Credit Hours

Areas	UET Credit Hours	UET Cr Hr %	NCEAC Credit Hours	NCEAC Cr Hr %
Computing Core	46	34.3%	46	35%
Domain Core	18	13.4%	18	14%
Specialization Domain Core + Elective	21	15.7%	21	16%
Mathematics & Supporting Courses (MSC)	12	8.9%	12	9%
Elective Supporting Courses (ESC)	3	2.23%	3	2%
General Education Requirement (GER)	29	21.6%	30	23%
University Elective (UE)	5	3.7%	0	0
Total	**134**	**100**	**130**	**100**

Semester-wise Comparison of NCEAC and UET Credit Hours

	I	II	III	IV	V	VI	VII	VIII	Total
NCEAC Theory	14	14	15	14	12	12	13	6	100
UET Theory	14	15	15	15	16	14	14	8	111
NCEAC Lab	2	3	4	3	5	6	3	4	30
UET Lab	3	4	3	4	1	2	2	4	23

NCEAC Total Credit Hours 130 (Theory Hours: 100 + Lab Hours 30 = 130)
UET Total Credit Hours   134 (Theory Hours: 111 + Lab Hours 23 = 134)

New Coding Scheme

CSC- Computer Science, SE-Software Engineering
1st Digit represents Year of Course Offering
2nd Digit represents Specialization/Knowledge Area (from following Table)
3rd Digit: Course Ordering in Specialization/Knowledge Area

2nd Digit	Specialization Domains / Knowledge Area
0	Computing Core and CS Domain Core
1-4	Computer Science Domain Electives
5-6	Artificial Intelligence Specialization Electives
7	Cyber Security Specialization Electives
8	Data Science Specialization Electives
9	Multimedia and Gaming Specialization Electives

Mapping of BS CS Program on the HEC Generic Structure

Computing Core (14 Courses and 46 Credit Hours)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
01	CSC102		Programming Fundamentals	Computing Core	4 (3-1)
02	CSC103	PF	Object Oriented Programming	Computing Core	4 (3-1)
03	CSC104		Database Systems	Computing Core	4 (3-1)
04	CSC105		Digital Logic Design	Computing Core	3 (2-1)
05	CSC200	OOP	Data Structures and Algorithms	Computing Core	4 (3-1)
06	CSC201		Information Security	Computing Core	3 (2-1)
07	CSC202		Artificial Intelligence	Computing Core	3 (2-1)
08	CSC203		Computer Networks	Computing Core	3 (2-1)
09	CSC204		Software Engineering	Computing Core	3 (3-0)
10	CSC205	DLD	Computer Organization & Assembly Language	Computing Core	3 (2-1)
11	CSC300		Operating Systems	Computing Core	3 (2-1)
12	CSC207	DS	Design and Analysis of Algorithms	Computing Core	3 (3-0)
13	CSC401		Final Year Project – I	Computing Core	2 (0-2)
14	CSC402	FYP-I	Final Year Project – II	Computing Core	4 (0-4)
				Total	**46 (30-16)**

Domain Core (06 Courses and 18 Credit Hours)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
01	CSC206		Theory of Automata	Domain Core	3 (3-0)
02	CSC207	DB	Advanced Database Management Systems	Domain Core	3 (2-1)
03	CSC301		Introduction to Human Computer Interaction	Domain Core	3 (3-0)
04	CSC302	COAL	Computer Architecture	Domain Core	3 (3-0)
05	CSC303		Compiler Construction	Domain Core	3 (2-1)
06	CSC304	OOP, OS	Parallel and Distributed Computing	Domain Core	3 (2-1)
			Total		**18 (15-3)**

Domain Electives (07 Courses and 21 Credit Hours)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
01	CSC-XXX		Domain Elective Workshop Practice	Domain Elective	3(3-0)
02	CSC-XXX		Domain Elective II	Domain Elective	3(3-0)
03	CSC-XXX		Domain Elective III	Domain Elective	3(3-0)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
04	CSC-XXX		Domain Elective IV	Domain Elective	**3(3-0)**
05	CSC-XXX		Domain Elective V	Domain Elective	**3(3-0)**
06	CSC-XXX		Domain Elective VI	Domain Elective	**3(3-0)**
07	CSC-XXX		Domain Elective VII	Domain Elective	**3(3-0)**
				Total	**21 (21-0)**

Math and Supporting Courses (04 Courses and 12 Credit Hours)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
01	MA-104	Calculus	Calculus II	MSC	**3 (3-0)**
02	MA-234	Calculus	Linear Algebra	MSC	**3 (3-0)**
03	MA-205		Applied Statistics and Probability	MSC	**3 (3-0)**
04	HU-221		Technical Writing & Presentation Skills	MSC	**3 (3-0)**
				Total	**12 (12-0)**

Elective Supporting Courses (01 Courses and 3 Credit Hours)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
01	MGT-XXX		Social Science (e.g. MGT-230 Principles of Marketing/MGT-412 Strategic Business Mgmt)	ESC	**3 (3-0)**
				Total	3 (3-0)

General Education Requirements (12 Courses and 29 Credit Hours)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
01	CSC100		Application of Information and Communication Technologies	GER	**3 (2-1)**
02	HU-102		Functional English	GER	**3 (3-0)**
03	HU-111L		Communication Skills (Lab)	GER	**1 (0-1)**
04	CSC101		Discrete Mathematics	GER	**3 (3-0)**
05	MA-123		Calculus	GER	**3 (3-0)**
06	IS-101		Islamic & Pakistan Studies-I	GER	**2 (2-0)**
07	IS-201		Islamic & Pakistan Studies-II	GER	**2 (2-0)**
08	HU-XXX		General Education (e.g. HU-240 Psychology)	GER	**2 (2-0)**
09	PHY-111		Applied Physics	GER	**3 (2-1)**
10	MGT-424		Leadership Strategies (or Community and Civic Engagement)	GER	**3 (3-0)**
11	CSC403		Professional Practices in Software Development	GER	**2 (2-0)**
12	MGT-414		Entrepreneurship & Business Management	GER	**2 (2-0)**

				Total	29 (26-3)

University Electives / Requirement (06 Course – 05 Credit Hours)

#	Code	Pre-Req	Course Title	HEC Domain	Cr Hr
01	ME-100L		Workshop Practice	UE	1 (0-1)
02	QT-101		Translation of the Holy Quran-I	UE	1 (1-0)
03	QT-201		Translation of the Holy Quran-II	UE	1 (1-0)
04	QT-301		Translation of the Holy Quran-III	UE	1 (1-0)
05	QT-401		Translation of the Holy Quran-IV	UE	1 (1-0)
06	HU-XXX		International Language	UE	0 (0-0)
				Total	5-0

UET Semester-wise Proposed Study Plan of BSCS with Specializations

#	New Code	Pre-Req	UET Course Title	HEC Domain	Cr Hr (Th-Lab)
			Semester 1		
1	CSC102		Programming Fundamentals	Computing Core	4 (3-1)
2	CSC100		Application of Information and Communication Technologies	GER	3 (2-1)
3	CSC101		Discrete Mathematics	GER	3 (3-0)
4	MA-123		Calculus	GER	3 (3-0)
5	HU-102		Functional English	GER	3 (3-0)
6	ME-100L		Workshop Practice	UE	1 (0-1)
				Total Cr Hrs	**17 (14-3)**
			Semester 2		
7	CSC103	PF	Object Oriented Programming	Computing Core	4 (3-1)
8	CSC104		Database Systems	Computing Core	4 (3-1)
9	CSC105		Digital Logic Design	Computing Core	3 (2-1)
10	MA-104	Calculus	Calculus II	MSC	3 (3-0)
11	MA-205		Applied Statistics and Probability	MSC	3 (3-0)
12	HU-111L		Communication Skills (Lab)	GER	1 (0-1)
13	QT-101		Translation of the Holy Quran-I	UE	1 (1-0)
				Total Cr Hrs	**19 (15-4)**
			Semester 3		
14	CSC200	OOP	Data Structures and Algorithms	Computing Core	4 (3-1)
15	MA-234	Calculus	Linear Algebra	MSC	3 (3-0)
16	PHY-111		Applied Physics	GER	3 (2-1)
17	CSC203		Computer Networks	Computing Core	3 (2-1)
18	CSC204		Software Engineering	Computing Core	3 (3-0)
19	IS-101		Islamic & Pakistan Studies-I	GER	2 (2-0)
				Total Cr Hrs	**18 (15-3)**
			Semester 4		
20	CSC205	DLD	Computer Organization and Assembly Language	Computing Core	3 (2-1)
21	CSC201		Information Security	Computing Core	3 (2-1)
22	CSC202		Artificial Intelligence	Computing Core	3 (2-1)
23	CSC206		Theory of Automata	Domain Core	3 (3-0)
24	CSC208	DS	Design and Analysis of Algorithms	Computing Core	3 (3-0)
25	CSC207	DB	Advanced Database Management Systems	Domain Core	3 (2-1)
26	QT-201		Translation of the Holy Quran-II	UE	1 (1-0)
				Total Cr Hrs	**19 (15-4)**

			Semester 5		
27	CSC300		Operating Systems	Computing Core	3 (2-1)
28	CSC301		Introduction to Human Computer Interaction	Domain Core	3 (3-0)
29	CSC302	COAL	Computer Architecture	Domain Core	3 (3-0)
30	CSCXXX		Specialization Elective 1	Specialization Elective	3 (3-0)
31	CSCXXX		Specialization Elective 2	Specialization Elective	3 (3-0)
32	HU-XXX		General Education (e.g. HU-240 Psychology)	GER	2 (2-0)
				Total Cr Hrs	17 (16-1)
			Semester 6		
33	CSC303		Compiler Construction	Domain Core	3 (2-1)
34	CSC304	OOP,OS	Parallel and Distributed Computing	Domain Core	3 (2-1)
35	CSCXXX		Specialization Elective 3	Specialization Elective	3 (3-0)
36	CSCXXX		Specialization Elective 4	Specialization Elective	3 (3-0)
37	MGT-XXX		Social Science (e.g. MGT-230 Principles of Marketing/MGT-412 Strategic Business Mgmt)	ESC	3 (3-0)
38	QT-301		Translation of the Holy Quran-III	UE	1 (1-0)
				Total Cr Hrs	16 (14-2)
			Semester 7		
39	CSC401		Final Year Project – I	Computing Core	2 (0-2)
40	CSCXXX		Specialization Elective 5	Specialization Elective	3 (3-0)
41	CSCXXX		Specialization Elective 6	Specialization Elective	3 (3-0)
42	MGT-424		Leadership Strategies (or Community and Civic Engagement)	GER	3 (3-0)
43	HU-221		Technical Writing and Presentation Skills	MSC	3 (3-0)
44	MGT-414		Entrepreneurship & Business Management	GER	2 (2-0)
				Total Cr Hrs	16 (14-2)
			Semester 8		
45	CSC402	FYP-I	Final Year Project – II	Computing Core	4 (0-4)
46	CSCXXX		Specialization Elective 7	Specialization Elective	3 (3-0)
47	IS-201		Islamic & Pakistan Studies – II	GER	2 (2-0)
48	CSC403		Professional Practices in Software Development	GER	2 (2-0)
49	QT-401		Translation of the Holy Quran-IV	UE	1 (1-0)
50	HU-XXX		International Language	UE	0 (0-0)
				Total Cr Hrs	12 (8-4)

Criteria for Specialization

Out of seven elective courses, student must choose at least five courses from any single specialization (AI, CY, DS, MG) to mention that particular specialization on the BSCS degree e.g., BSCS (Data Science Specialization). However, for BSCS without any specialization, any seven courses from the following list of electives can be taken. The BSCS degree program offers the following four specializations:

1) Artificial Intelligence (AI)
2) Cyber security (CY)
3) Data Science (DS)
4) Multimedia and Gaming (MG)

List of All Electives Courses

Old Code	New Code	Course Title	Specialization	Cr Hrs	Status
CS-380	CSC310	Graph Theory		3 (3-0)	Approved
CS-201	CSC311	Numerical Analysis		3 (3-0)	Approved
CS-382	CSC312	Operations Research		3 (3-0)	Approved
CS-445	CSC313	Programming Languages		3 (3-0)	Approved
CS-481	CSC314	Real Time Systems		3 (3-0)	Approved
CS-491	CSC315	Wireless Networks		3 (3-0)	Approved
CS-496	CSC316	Linux Kernel Implementation		3 (3-0)	Approved
CS-492	CSC317	Internetworking with Unix TCP/IP		3 (3-0)	Approved
CS-390	CSC318	System Programming		3 (3-0)	Approved
CS-351	CSC319	Computer Graphics	MG	3 (3-0)	Approved
CS-394	CSC410	Mobile Application Development		3 (3-0)	Approved
CS-393	CSC411	Open-Source Software Development		3 (3-0)	Approved
New	CSC412	Advanced Programming Techniques (Pre Req: OOP)		3 (3-0)	New
CS-494	CSC413	E-Commerce		3 (3-0)	Approved
CS-493	CSC414	Enterprise Application Development		3 (3-0)	Approved
CS-391	CSC415	Web Technologies	MG	3 (3-0)	Approved
CS-396	CSC420	Object Oriented Analysis and Design		3 (3-0)	Approved
CS-397	CSC421	Design Patterns		3 (3-0)	Approved
CS-353	CSC422	Management Information Systems		3 (3-0)	Approved
CS-497	CSC423	Intro to Program Analysis		3 (3-0)	Approved
CS-498	CSC424	Formal Methods		3 (3-0)	Approved
CS-583	CSC425	Leading Software Teams		3 (3-0)	Approved
CS-584	CSC426	Habits of Highly Effective Software Engineer		3 (3-0)	Approved
CS-585	CSC427	Personal, Team and Executive Software Processes		3 (3-0)	Approved
CS-388	CSC430	Database Backup & Recovery		3 (3-0)	Approved
CS-389	CSC431	Distributed Databases		3 (3-0)	Approved

CS-581	CSC432	Graph Databases		3 (3-0)	Approved
CS-386	CSC433	Database Administration		3 (3-0)	Approved
CS-387	CSC434	Database Performance & Optimization		3 (3-0)	Approved
SE-211	SE-211	Software Requirements Engineering		3 (3-0)	Approved
SE-222	SE-222	Software Design & Architecture		3 (3-0)	Approved
SE-323	SE-323	Software Construction and Development		3 (3-0)	Approved
SE-324	SE-324	Principles of Web Engineering	MG	3 (3-0)	Approved
SE-325	SE-325	UX/UI Design	MG	3 (3-0)	Approved
SE-331	SE-331	Software Quality Engineering		3 (3-0)	Approved
SE-332	SE-332	Software Measurement & Metrics		3 (3-0)	Approved
SE-441	SE-341	Software Project Management		3 (3-0)	Approved
SE-442	SE-442	Software Re-Engineering		3 (3-0)	Approved
SE-453	SE-453	Software Engineering Economics		3 (3-0)	Approved
SE-454	SE-454	Topics in Software Engineering		3 (3-0)	Approved
CS-356	CSC350	Programming for AI	AI	3 (3-0)	Approved
CS-489	CSC351	Machine Learning	AI, DS	3 (3-0)	Approved
CS-452	CSC352	Introduction to Deep Learning	AI, DS	3 (3-0)	Approved
CS-357	CSC353	Knowledge Representation and Reasoning	AI	3 (3-0)	Approved
CS-485	CSC354	Computer Vision and Image Processing	AI	3 (3-0)	Approved
CS-358	CSC450	Philosophical Foundations of AI	AI	3 (3-0)	Approved
CS-354	CSC451	Natural Language Processing	AI	3 (3-0)	Approved
New	CSC452	Speech Processing	AI, MG	3 (3-0)	New
CS-490	CSC453	Soft Computing	AI	3 (3-0)	Approved
CS-450	CSC454	Agent Based Modelling	AI	3 (3-0)	Approved
CS-586	CSC455	Logical Paradigms of Computing	AI	3 (3-0)	Approved
CS-383	CSC456	Simulation and Modelling	AI	3 (3-0)	Approved
CS-582	CSC457	Web Semantics	AI, DS	3 (3-0)	Approved
CS-488	CSC458	Information Retrieval	AI, DS	3 (3-0)	Approved
CS-451	CSC459	Introduction to Bioinformatics	AI, DS	3 (3-0)	Approved
CS-360	CSC370	Fundamentals of Cyber Security (Pre Req Info. Security)	CY	3 (3-0)	Approved
CS-363	CSC371	Information Assurance	CY	3 (3-0)	Approved
CS-361	CSC372	Network Security	CY	3 (3-0)	Approved
CS-367	CSC373	Secure Software Design and Development	CY	3 (3-0)	Approved
CS-362	CSC374	Digital Forensics	CY	3 (3-0)	Approved
CS-368	CSC470	Vulnerability Assessment and Reverse Engineering	CY	3 (3-0)	Approved
CS-365	CSC471	Malware Analysis and Development	CY	3 (3-0)	Approved
CS-366	CSC472	Penetration Testing	CY	3 (3-0)	Approved
CS-487	CSC473	Ethical Hacking	CY	3 (3-0)	Approved
CS-369	CSC474	Cryptography and Cryptanalysis	CY	3 (3-0)	Approved
CS-384	CSC380	Introduction to Data Science	DS	3 (3-0)	Approved
CS-399	CSC381	Statistics for Data Science	AI, DS	3 (3-0)	Approved
CS-355	CSC382	Data Mining	AI, DS	3 (3-0)	Approved

CS-499	CSC383	Data Visualization	DS	3 (3-0)	Approved
CS-484	CSC384	Data Warehousing and Business Intelligence	DS	3 (3-0)	Approved
CS-482	CSC480	Big Data Analytics	AI, DS	3 (3-0)	Approved
CS-483	CSC481	Cloud Computing	AI, DS	3 (3-0)	Approved
CS-385	CSC482	Internet of Things	AI, DS	3 (3-0)	Approved
New	CSC483	Business Process Analysis	DS	3 (3-0)	New
New	CSC484	Platforms and Architectures for Data Science	DS	3 (3-0)	New
New	CSC485	Text Mining	AI, DS	3 (3-0)	New
New	CSC486	Topics in Data Science	DS	3 (3-0)	New
New	CSC390	Mobile Multimedia	MG	3 (3-0)	New
CS-392	CSC391	Game Development	MG	3 (3-0)	Approved
New	CSC392	Interactive Games and Audio	MG	3 (3-0)	New
New	CSC393	Game Programming	MG	3 (3-0)	New
New	CSC394	Video Production Techniques	MG	3 (3-0)	New
New	CSC490	Game Play and Game Mechanics	MG	3 (3-0)	New
New	CSC491	3D Game Development	MG	3 (3-0)	New
New	CSC492	Programming Game AI	MG	3 (3-0)	New
New	CSC493	Game Marketing	MG	3 (3-0)	New

List of Elective Courses for Multimedia and Gaming Specialization

Old Code	New Code	Course Title	Specialization	Cr Hrs	Status
CS-351	CSC319	Computer Graphics	MG	3 (3-0)	Approved
New	CSC390	Mobile Multimedia	MG	3 (3-0)	New
CS-392	CSC391	Game Development	MG	3 (3-0)	Approved
New	CSC392	Interactive Games and Audio	MG	3 (3-0)	New
New	CSC393	Game Programming	MG	3 (3-0)	New
New	CSC394	Video Production Techniques	MG	3 (3-0)	New
CS-391	CSC415	Web Technologies	MG	3 (3-0)	Approved
New	CSC452	Speech Processing	MG	3 (3-0)	New
New	CSC490	Game Play and Game Mechanics	MG	3 (3-0)	New
New	CSC491	3D Game Development	MG	3 (3-0)	New
New	CSC492	Programming Game AI	MG	3 (3-0)	New
New	CSC493	Game Marketing	MG	3 (3-0)	New
SE-324	SE-324	Principles of Web Engineering	MG	3 (3-0)	Approved
SE-325	SE-325	UX/UI Design	MG	3 (3-0)	Approved

List of Elective Courses for Artificial Intelligence Specialization

Old Code	New Code	Course Title	Specialization	Cr Hrs	Status
CS-356	CSC350	Programming for AI	AI	3 (3-0)	Approved
CS-489	CSC351	Machine Learning	AI	3 (3-0)	Approved
CS-452	CSC352	Introduction to Deep Learning	AI	3 (3-0)	Approved

CS-357	CSC353	Knowledge Representation and Reasoning	AI	3 (3-0)	Approved
CS-485	CSC354	Computer Vision and Image Processing	AI	3 (3-0)	Approved
CS-399	CSC381	Statistics for Data Science	AI	3 (3-0)	Approved
CS-355	CSC382	Data Mining	AI	3 (3-0)	Approved
CS-358	CSC450	Philosophical Foundations of AI	AI	3 (3-0)	Approved
CS-354	CSC451	Natural Language Processing	AI	3 (3-0)	Approved
New	CSC452	Speech Processing	AI	3 (3-0)	New
CS-490	CSC453	Soft Computing	AI	3 (3-0)	Approved
CS-450	CSC454	Agent Based Modelling	AI	3 (3-0)	Approved
CS-586	CSC455	Logical Paradigms of Computing	AI	3 (3-0)	Approved
CS-383	CSC456	Simulation and Modelling	AI	3 (3-0)	Approved
CS-582	CSC457	Web Semantics	AI	3 (3-0)	Approved
CS-488	CSC458	Information Retrieval	AI	3 (3-0)	Approved
CS-451	CSC459	Introduction to Bioinformatics	AI	3 (3-0)	Approved
CS-482	CSC480	Big Data Analytics	AI	3 (3-0)	Approved
CS-483	CSC481	Cloud Computing	AI	3 (3-0)	Approved
CS-385	CSC482	Internet of Things	AI	3 (3-0)	Approved
New	CSC485	Text Mining	AI	3 (3-0)	New

List of Elective Courses for Cyber Security Specialization

Old Code	New Code	Course Title	Specialization	Cr Hrs	Status
CS-360	CSC370	Fundamentals of Cyber Security (Pre Req Info. Security)	CY	3 (3-0)	Approved
CS-363	CSC371	Information Assurance	CY	3 (3-0)	Approved
CS-361	CSC372	Network Security	CY	3 (3-0)	Approved
CS-367	CSC373	Secure Software Design and Development	CY	3 (3-0)	Approved
CS-362	CSC374	Digital Forensics	CY	3 (3-0)	Approved
CS-368	CSC470	Vulnerability Assessment and Reverse Engineering	CY	3 (3-0)	Approved
CS-365	CSC471	Malware Analysis and Development	CY	3 (3-0)	Approved
CS-366	CSC472	Penetration Testing	CY	3 (3-0)	Approved
CS-487	CSC473	Ethical Hacking	CY	3 (3-0)	Approved
CS-369	CSC474	Cryptography and Cryptanalysis	CY	3 (3-0)	Approved

List of Elective Courses for Data Science Specialization

Old Code	New Code	Course Title	Specialization	Cr Hrs	Status
CS-489	CSC351	Machine Learning	DS	3 (3-0)	Approved
CS-452	CSC352	Introduction to Deep Learning	DS	3 (3-0)	Approved
CS-384	CSC380	Introduction to Data Science	DS	3 (3-0)	Approved
CS-399	CSC381	Statistics for Data Science	DS	3 (3-0)	Approved
CS-355	CSC382	Data Mining	DS	3 (3-0)	Approved
CS-499	CSC383	Data Visualization	DS	3 (3-0)	Approved

CS-484	CSC384	Data Warehousing and Business Intelligence	DS	3 (3-0)	Approved
CS-582	CSC457	Web Semantics	DS	3 (3-0)	Approved
CS-488	CSC458	Information Retrieval	DS	3 (3-0)	Approved
CS-451	CSC459	Introduction to Bioinformatics	DS	3 (3-0)	Approved
CS-482	CSC480	Big Data Analytics	DS	3 (3-0)	Approved
CS-483	CSC481	Cloud Computing	DS	3 (3-0)	Approved
CS-385	CSC482	Internet of Things	DS	3 (3-0)	Approved
New	CSC483	Business Process Analysis	DS	3 (3-0)	New
New	CSC484	Platforms and Architectures for Data Science	DS	3 (3-0)	New
New	CSC485	Text Mining	DS	3 (3-0)	New
New	CSC486	Topics in Data Science	DS	3 (3-0)	New

Course Outlines

CSC102 Programming Fundamentals (3-1)
Contents: Introduction to problem-solving, a brief review of Von-Neumann architecture, Introduction to programming, the role of compiler and linker, introduction to algorithms, basic data types and variables, input/output constructs, arithmetic, comparison, and logical operators, conditional statements and execution flow for conditional statements, repetitive statements, and execution flow for repetitive statements, lists and their memory organization, multi-dimensional lists, introduction to modular programming, function definition and calling, stack rolling and unrolling, string and string operations, pointers/references, static and dynamic memory allocation, File I/O operations
Text Book: 1. Starting out with Python, 4th Edition, Tony Gaddis 2. Starting out with Programming Logic & Designs, 4th Edition, Tony Gaddis

CSC100 Application of Information and Communication Technologies (2-1)
Contents: Introduction to ICT: Definition and overview of Information and Communication Technologies (ICT)., ICT Terminologies: Understanding key terms and concepts related to ICT., Hardware, and Software Components: Overview of the hardware and software components that make up ICT systems., The Internet and World Wide Web: Understanding the infrastructure and services that make up the Internet and World Wide Web., Wireless and Mobile Communications: Overview of technologies that enable wireless and mobile communications such as Wi-Fi, mobile cellular networks, and the Internet of Things., ICT-Based Applications: Understanding the various applications of ICT in different fields such as education, business, healthcare, etc., Challenges and Opportunities: Discussion of the challenges and opportunities presented by the widespread adoption of ICT
Text Book: 1. Information and Communication Technology in Organizations: Adoption, 2. Implementation, Use and Effects By:Harry Bouwman, Bart van den Hooff, 3. Lidwien van de Wijngaert & Jan van Dijk, Publisher: SAGE Publications Ltd, Publication year: 2005, Online pub date: June 19, 2012,

CSC101 Discrete Mathematics (3-0)
Contents: Mathematical reasoning, propositional and predicate logic, rules of inference, proof by induction, proof by contraposition, proof by contradiction, proof by implication, set theory,

relations, equivalence relations and partitions, partial orderings, recurrence relations, functions, mappings, function composition, inverse functions, recursive functions, Number Theory, sequences, series, counting, inclusion and exclusion principle, pigeonhole principle, permutations and combinations, elements of graph theory, planar graphs, graph coloring, Euler graph, Hamiltonian path, rooted trees, traversals

Text Book:
1. Discrete Mathematics and Its Applications, 7th edition by Kenneth H. Rosen
2. Discrete Mathematics with Applications, 4th Edition by Susanna S. Epp
3. Discrete Mathematics, 7th edition by Richard Johnson Baugh

CSC103 Object-Oriented Programming (3-1)

Contents:
Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M way trees, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, memory management, and garbage collection.

Text Book:
1. Data Structures and Algorithms in C++ by Adam Drozdek
2. Data Structures and Algorithm Analysis in Java by Mark A. Weiss
3. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry

CSC104 Database Systems (3-1)

Contents:
Basic database concepts, Database approach vs file-based system, database architecture, three-level schema architecture, data independence, relational data model, attributes, schemas, tuples, domains, relation instances, keys of relations, integrity constraints, relational algebra, selection, projection, Cartesian product, types of joins, normalization, functional dependencies, normal forms, entity-relationship model, entity sets, attributes, relationship, entity-relationship diagrams, Structured Query Language (SQL), Joins and subqueries in SQL, Grouping and aggregation in SQL, concurrency control, database backup and recovery, indexes, NoSQL systems

Text Book:
1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th

Edition by Thomas Connolly and Carolyn Begg
2. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D. Ullman, Jennifer Widom
3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan

---

CSC105 Digital Logic Design (2-1)

Contents:
Number Systems, Logic Gates, Boolean Algebra, Combinational logic circuits and designs, Simplification Methods (K-Map, Quinn McCluskey method), Flip Flops and Latches, Asynchronous and Synchronous circuits, Counters, Shift Registers, Counters, Triggered devices & its types. Binary Arithmetic and Arithmetic Circuits, Memory Elements, and State Machines. Introduction Programmable Logic Devices (CPLD, FPGA); Lab Assignments using tools such as Verilog HDL/VHDL, MultiSim

Text Book:
1. Digital Fundamentals by Floyd, 11/e.
2. Fundamental of Digital Logic with Verilog Design, Stephen Brown, 2/e.

CSC200 Data Structures and Algorithms (3-1)

Contents:
Abstract data types, complexity analysis, Big Oh notation, Stacks (linked lists and array implementations), Recursion and analyzing recursive algorithms, divide and conquer algorithms, Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket), queue, dequeuer, priority queues (linked and array implementations of queues), linked list & its various types, sorted linked list, searching an unsorted array, binary search for sorted arrays, hashing and indexing, open addressing and chaining, trees and tree traversals, binary search trees, heaps, M-way trees, balanced trees, graphs, breadth-first and depth-first traversal, topological order, shortest path, adjacency matrix and adjacency list implementations, memory management and garbage collection

Text Book:
1. Data Structures and Algorithm Analysis in Java by Mark A. Weiss
2. Data Structures and Abstractions with Java by Frank M. Carrano & Timothy M. Henry
3. Data Structures and Algorithms in C++ by Adam Drozdek

CSC201 Information Security (2-1)

Contents:
Information security foundations, security design principles; security mechanisms, symmetric

and asymmetric cryptography, encryption, hash functions, digital signatures, key management, authentication, and access control; software security, vulnerabilities and protections, malware, database security; network security, firewalls, intrusion detection; security policies, policy formation and enforcement, risk assessment, cybercrime, law and ethics in information security, privacy and anonymity of data

Text Book:
1. Computer Security: Principles and Practice, 3rd edition by William Stallings
2. Principles of Information Security, 6th edition by M. Whitman and H. Mattord
3. Computer Security, 3rd edition by Dieter Gollmann

CSC202 Artificial Intelligence (2-1)

Contents:
An Introduction to Artificial Intelligence and its applications towards Knowledge-Based Systems; Introduction to Reasoning and Knowledge Representation, Problem-Solving by Searching (Informed searching, Uninformed searching, Heuristics, Local searching, Minmax algorithm, Alpha-beta pruning, Game-playing); Case Studies: General Problem Solver, Eliza, Student, Macsyma; Learning from examples; ANN and Natural Language Processing; Recent trends in AI and applications of AI algorithms. Python programming language will be used to explore and illustrate various issues and techniques in Artificial Intelligence.

Text Book:
1. Russell, S. and Norvig, P. "Artificial Intelligence. A Modern Approach", 3rd ed, Prentice Hall, Inc., 2015.
2. Norvig, P., "Paradigms of Artificial Intelligence Programming: Case studies in Common Lisp", Morgan Kaufman Publishers, Inc., 1992.
3. Luger, G.F. and Stubblefield, W.A., "AI algorithms, data structures, and idioms in Prolog, Lisp, and Java", Pearson Addison-Wesley. 2009.
4. Severance, C.R., 2016. "Python for Everybody: Exploring data using Python 3." CreateSpace Independent Publ Platform.

CSC203 Computer Networks (2-1)

Contents:
Introduction and protocols architecture, basic concepts of networking, network topologies, layered architecture, physical layer functionality, data link layer functionality, multiple access techniques, circuit switching and packet switching, LAN technologies, wireless networks, MAC addressing, networking devices, network layer protocols, IPv4 and IPv6, IP addressing, subnetting, CIDR, routing protocols, transport layer protocols, ports and sockets, connection establishment, flow and congestion control, application layer protocols, latest trends in computer networks

Text Book:
1. Computer Networking: A Top-Down Approach Featuring the Internet, 6th edition by James F. Kurose and Keith W. Ross
2. Computer Networks, 5th Edition by Andrew S. Tanenbaum
3. Data and Computer Communications, 10th Edition by William Stallings
4. Data Communication and Computer Networks, 5th Edition by Behrouz A. Forouzan

---

CSC204 Software Engineering (3-0)

Contents:
Nature of Software, Overview of Software Engineering, Professional software development, Software engineering practice, Software process structure, Software process models, Agile Software Development, Agile process models, Agile development techniques, Requirements engineering process, Functional and non-functional requirements, Context models, Interaction models, Structural models, behavioral models, model-driven engineering, Architectural design, Design and implementation, UML diagrams, Design patterns, Software testing and quality assurance, Software evolution, Project management and project planning, configuration management, Software Process improvement

Text Book:
1. Software Engineering, Sommerville I., 10th Edition, Pearson Inc., 2014
2. Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., 8th Edition, McGraw-Hill, 2015.

CSC205 Computer Organization and Assembly Language (2-1)

Contents:
Introduction to computer systems: Information is bits + context, programs are translated by other programs into different forms, it pays to understand how compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations

Text Book:

1. Computer System Architecture, M. Morris Mano, Latest Edition,
2. Assembly Language Programming for Intel- Computer, Latest Edition
3. Computer Systems: A Programmer's Perspective, 3/E (CS:APP3e), Randal E. Bryant and David R.O' Hallaron, Carnegie Mellon University
4. Robert Britton, MIPS Assembly Language Programming, Latest Edition

CSC206 Theory of Automata (3-0)

Contents:
Finite State Models: Language definitions preliminaries, Regular expressions/Regular languages, Finite automata (FAs), Transition graphs (TGs), NFAs, Kleene's theorem, Transducers (automata with output), Pumping lemma and non-regular language Grammars and PDA: CFGs, Derivations, derivation trees, and ambiguity, Simplifying CFLs, Normal form grammars and parsing, Decidability, Context-sensitive languages, grammars and linear bounded automata (LBA), Chomsky's hierarchy of grammars Turing Machines Theory: Turing machines, Post machine, Variations on TM, TM encoding, Universal Turing Machine, Defining Computers by TMs.

Text Book:
1. Introduction to computer theory, Daniel I. A. Cohen, 2_{nd} Edition
2. Automata, Computability, and Complexity: Theory and Applications, by Elaine Rich, 2011
3. An Introduction to Formal Languages and Automata, by Peter Linz, 4_{th} edition, Jones & Bartlett Publishers, 2006
4. Theory of Automata, Formal Languages and Computation, by S. P. Eugene, Kavier, 2005, New Age Publishers

CSC207 Advanced Database Management Systems (2-1)

Contents:
Introduction to advance data models such as object-relational, object-oriented. File organizations concepts, Transactional processing and Concurrency control techniques, Recovery techniques, Query processing, and optimization, Database Programming (PL/SQL, T-SQL or similar technology), Integrity and security, Database Administration (Role management, managing database access, views), Physical database design and tuning, Distributed database systems, Emerging research trends in database systems, MONGO DB, NO SQL (or similar technologies)

Text Book:
1. Database Systems: A Practical Approach to Design, Implementation, and Management, 6th Edition by Thomas Connolly and Carolyn Begg
2. Database Management Systems, 3rd Edition by Raghu Ramakrishnan, Johannes Gehrke
3. Database System Concepts, 6th Edition by Avi Silberschatz, Henry F. Korth and S. Sudarshan.
4. Database Systems: The Complete Book, 2nd Edition by Hector Garcia-Molina, Jeffrey D.

Ullman, Jennifer Widom

CSC300 Operating Systems (2-1)

Contents:
Operating systems basics, system calls, process concept and scheduling, inter-process communication, multithreaded programming, multithreading models, threading issues, process scheduling algorithms, thread scheduling, multiple-processor scheduling, synchronization, critical section, synchronization hardware, synchronization problems, deadlocks, detecting and recovering from deadlocks, memory management, swapping, contiguous memory allocation, segmentation & paging, virtual memory management, demand paging, thrashing, memory-mapped files, file systems, file concept, directory and disk structure, directory implementation, free space management, disk structure and scheduling, swap space management, system protection, virtual machines, operating system security

Text Book:
1. Operating Systems Concepts, 9th edition by Abraham Silberschatz
2. Modern Operating Systems, 4th edition by Andrew S. Tanenbaum
3. Operating Systems, Internals and Design Principles, 9th edition by William Stallings

CSC301 Introduction to Human Computer Interaction (3-0)

Contents:
Contexts for HCI, Psychology of usable things, Processes for User-Centered Design, Metrics, and Measures for Evaluation, Usability heuristics and principles of Usability testing, Physical capabilities, Cognitive and social models for interaction design, Principles of good interaction design, Accessibility, Principles of GUI, Visual design elements, Data gathering, Task analysis, Prototyping, Help and user documentation, Internationalization, Usability inspection methods, Usability testing methods, New Interaction Technologies, Usability in practice, Visual Design and Typography, Icon Design, Ubiquitous, Augmented and Virtual Reality

Text Book:
1. Designing the User Interface: Strategies for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, 6th Ed, Pearson Inc, 2016.
2. Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design, Benyon, D. 3rd Ed., Pearson. 2013
3. About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, 4th Ed, Wiley, 2014

CSC302 Computer Architecture (3-0)

Contents:

Introduction to computer systems: Information is bits + context, programs are translated by other programs into different forms, it pays to understand how compilation systems work, processors read and interpret instructions stored in memory, caches matter, storage devices form a hierarchy, the operating system manages the hardware, systems communicate with other systems using networks; Representing and manipulating information: information storage, integer representations, integer arithmetic, floating point; Machine-level representation of programs: a historical perspective, program encodings, data formats, accessing information, arithmetic and logical operations, control, procedures, array allocation and access, heterogeneous data structures, putting it together: understanding pointers, life in the real world: using the gdb debugger, out of-bounds memory references and buffer overflow, x86-64: extending ia32 to 64 bits, machine-level representations of floating-point programs; Processor architecture: the Y86 instruction set architecture, logic design and the Hardware Control Language (HCL), sequential Y86 implementations, general principles of pipelining, pipelined Y86 implementations

Text Book:

1. Computer System Architecture, M. Morris Mano, Latest Edition,
2. Assembly Language Programming for Intel- Computer, Latest Edition
3. Computer Systems: A Programmer's Perspective, 3/E (CS:APP3e), Randal E. Bryant and David R.O' Hallaron, Carnegie Mellon University
4. Robert Britton, MIPS Assembly Language Programming, Latest Edition,

CSC303 Compiler Construction (2-1)

Contents:

Introduction to interpreter and compiler. Compiler techniques and methodology; Organization of compilers; Lexical and syntax analysis; Parsing techniques. Types of parsers, top-down parsing, bottom-up parsing, Type checking, Semantic analyzer, Object code generation and optimization, detection and recovery from errors

Text Book:

1. Compilers: Principles, Techniques, and Tools, A. V. Aho, R. Sethi and J. D. Ullman, Addison-Wesley, 2nd ed., 2006
2. Modern Compiler Design, D. Grune, H. E. Bal, C. J. H. Jacobs, K. G. Langendoen, John Wiley, 2003.
3. Modern Compiler Implementation in C, A. W. Appel, M. Ginsburg, Cambridge University Press, 2004

CSC304 Parallel and Distributed Computing (2-1)

Contents:

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, synchronization, and tools (Cuda, Swift, Globus, Condor, Amazon AWS, OpenStack, Cilk, gdb, threads, MPICH, OpenMP, Hadoop, FUSE).

Text Book:
1. Distributed Systems: Principles and Paradigms, A. S. Tanenbaum and M. V. Steen, Prentice Hall, 2nd Edition, 2007
2. Distributed and Cloud Computing: Clusters, Grids, Clouds, and the Future Internet, K Hwang, J Dongarra, and GC. C. Fox, Elsevier, 1st Ed.

CSC208 Design and Analysis of Algorithms (3-0)

Contents:
Introduction; the role of algorithms in computing, Analysis on nature of input and size of input Asymptotic notations; Big-O, Big Ω, Big Θ, little-o, little-ω, Sorting Algorithm analysis, loop invariants, Recursion, and recurrence relations; Algorithm DesignTechniques, Brute Force Approach, Divide-and-conquer approach; Merge, Quick Sort, Greedy approach; Dynamic programming; Elements of Dynamic Programming, Search trees; Heaps; Hashing; Graph algorithms, shortest paths, sparse graphs, String matching; Introduction to complexity classes;

Text Book:
1. Introduction to Algorithms (3rd edition) by Thomas H. Corman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein
2. Algorithm Design, (1st edition, 2013/2014), Jon Kleinberg, Eva Tardos,
3. Algorithms, (4th edition, 2011), Robert Sedgewick, Kevin Wayne

---

CSC310 Graph Theory (3-0)

Contents:
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 the computer system, Matching Algorithms, Dominance & Ramsey theory.

Text Book:
1. Graph Theory & Applications (1st Edition) by Fournier. Published by Wiley-ISTE, 2011.
2. Applied Algorithmic Graph Theory (1st Edition) by Chartrand. Published by McGraw-Hill College, 1995

CSC311 Numerical Analysis (3-0)

Contents:
This is an introductory course on numerical methods and their applications. The primary objective of the course is to develop a basic understanding of the numerical methods, applicability, and limits of their appropriate use to compute approximate solutions to complex mathematical problems. It covers the following topics: Error Analysis, Finite Differences, Interpolation, Numerical Differentiation, Numerical Integration, Non-Linear Equations, and Linear Systems of Equations

Text Book:
1. Applied numerical analysis Book by Curtis Gerald
2. A first course in Numerical Analysis with C++ by Saeed Akhtar Bhatti
3. Introduction to numerical methods and analysis 2nd edition James F. Epperson
4. Numerical Analysis Richard L. Burden J.Douglas Faires 10th Edition

CSC312 Operations Research (3-0)

Contents:
Introduction to operations research, History of operations research, Applications, Modeling the linear programming, Linear programming, Geometry, Solving the linear programming, the Simplex method, Shadow price, Theory of the simplex method, Duality, Dual theory, Sensitivity analysis, Other algorithms for linear programming, The dual simple method, Big – M method, The tow phase method, The transportation and assignment problems, The transportation problem, A streamlined simplex method for transportation problem, The assignment problem, A special algorithm for the assignment problem, Dynamic programming, Characteristic of dynamic programming, Deterministic dynamic programming, Integer programming, Prototype examples, BIP applications and formulation examples, Some perspectives on solving integer programming problems, The branch-and-cut approach to solve BIP problems, The incorporation of constraint programming.

Text Book:
1. Frederick S. Hiller, Gerald J. Lieberman, Introduction to Operations Research, 9th Edition, English, McGraw-Hill, 2010.
2. W. Winston, Operations Research, Duxbury Press.
3. Operations Research: Applications and Algorithms, Wayne L Winston, Indian University, 4th edition, 2004

CSC313 Programming Languages (3-0)

Contents:
Introduction: Models of Computation, Syntax and Semantics, Pragmatics, Language Design Principles. Syntax and Semantics: Context-Free Grammar, Regular Expressions, Attribute Grammar and Static Semantics, Algebraic Semantics, Axiomatic Semantics, and Denotational Semantics. BNF grammar 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.

Text Book:
1. Concepts of Programming Languages, Robert W. Sebesta, 10th edition, 2012
2. Scott, Michael L., Programming Language Pragmatics, 2nd edition, 2006
3. Theory Introduction to Programming Languages, by Anthony A. Aaby, 2004

CSC314 Real-Time Systems (3-0)

Contents:
Introduction to Real-Time Systems, Categories, Characteristics and challenges, Requirement Specification and Design, Design fundamentals, Elements of modular design, Concurrency, Real-time & other application areas, Real-Time Operating Systems, Memory management, Fundamental of microprocessor-based systems, Input-output interfacing technique, Real-time programming, Real-Time Analysis, Schedulability analysis, Scheduling policies, Designing with rate-monotonic analysis

Text Book:
1. Software Engineering for Real-Time Systems, Cooling J., Addison-Wesley.
2. Real-time Systems and Programming Languages, 2nd Edition, Burns A., Wellings A.J., Addison Wesley, UK.
3. Principles of Concurrent and Distributed Programming. Ben-Ari M., Addison-Wesley, 2006.

CSC315 Wireless Networks (3-0)

Contents:
The course deals with the fundamental and practical aspects of the analysis and design of wireless systems. Topics that will be covered are the wireless communication channel, spectrum-efficient digital modulation techniques, their comparison and detection techniques, cellular communication principles, techniques used to combat the channel, an overview of multiple access techniques, and examples of wireless communication systems.

Text Book:

CSC315 Wireless Networks (3-0)
1. Introduction to Wireless Systems by P. M. Shankar. John Wiley & Sons, 2002.

CSC316 Linux Kernel Implementation (3-0)
Contents: Shell Scripting: running a bourne shell script ,shell variables and related commands passing arguments to shell scripts,comments and program headers program control flow commands , command grouping numeric data processing,the here document interrupt (signal) processing,the exec command and file i/o, functions in the bourne shell , debugging shell programs introduction, running a c shell script ,shell variables and related commands, reading and writing shell variables ,passing arguments to shell scripts,comments and program headers, program control flow commands ,numeric data processing, array processing ,the here document,interrupt (signal) processing,debugging shell programs system programming file system management ,entry points into the os kernel fundamentals of system calls, Files: the big picture: file tables, and inode tables fundamental file i/o paradigm standard i/o versus low-level i/o file manipulation getting file attributes from a file inode, restarting system calls, System Programming Process Management: Processes and threads, process management concepts, system calls for manipulating directories, processes and threads,process management concepts, processes and the file descriptor table, getting the attention of a process: unix signals, System Programming Inter Process Managment ipc: communication channels and communication types, ipc: important system and library calls, data, structures, macros, and header files, the client–server model, communication between unrelated processes on the same computer, communication between unrelated processes on different computers types of socket-based servers algorithms and examples for socket-based client– server software synchronous versus asynchronous i/o: the select(), System call, the unix superserver: inetd , concurrent clients system programming practical considerations:, Thread Safe System Calls, Detaching Daemons, opening and closing of standard descriptors, structure of a production server.
Text Book: 1. UNIX The Textbook Syed Mansoor Sarwar and Robert M. Koretsky, 3rd Edition,2016, ISBN-13: 978-1482233582 2. Linux Device Drivers, Jonathan Corbet, Alessandro Rubini, Greg Kroah-Hartman, 3rd Edition, 2005, 3. Linux The Textbook: Syed Mansoor Sarwar and Robert M. Koretsky, 2nd Edition.

CSC317 Internetworking with Unix TCP/IP (3-0)
Contents: This is designed to be a depth-first course with the main objective of teaching students the art of UNIX TCP/IP network programming with BSD sockets using the client-server paradigm. Students gain hands-on experience through the design, implementation, and testing of client-

CSC317 Internetworking with Unix TCP/IP (3-0)

server models for some simple Internet services. Programming language environment: C on UNIX/LINUX.

Text Book:
1. Douglas E. Comer and David L. Stevens, Internetworking with TCP/IP: Client-Server
2. Programming and Application, Vol. 3, Linux / POSIX Sockets Version, Prentice Hall, 2001.

CSC318 System Programming (3-0)

Contents:
Introduction to System Programming, Operating Systems Basics, Assembly Language fundamentals, System-Level Programming Languages, Device Drivers and Kernel Programming, Networking and Network Programming, System-Level Security, Performance Optimization and System Tuning, System-Level Debugging and Testing, Advanced Topics in System Programming, Micro-Controllers, OS for Microcontrollers, Sensor and Integration with Micro-Controllers.

Text Book:
1. Linux System Programming by Robert Love
2. System Programming by D M Dhamdhere

CSC319 Computer Graphics (3-0)

Contents:
Fundamental Concepts: forward and backward rendering (i.e., ray-casting and rasterization), applications of computer graphics: including game engines, cad, visualization, virtual reality, polygonal representation, basic radiometry, similar triangles, and projection model, use of standard graphics APIs (see HCI GUI construction); basic rendering: rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing, visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation, simple triangle rasterization, rendering with a shader-based API, texture mapping, including minification and magnification (e.g., trilinear MIP-mapping), application of spatial data structures to rendering, sampling and anti-aliasing, scene graphs and the graphics pipeline; geometric modeling: basic geometric operations such as intersection calculation, proximity tests, polynomial curves and surfaces, approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images.

Text Book:

CSC319 Computer Graphics (3-0)

1. Computer Graphics with Open GL (4th Edition) by Donald D. Hearn, Prentice Hall, 2010, ISBN-10: 0136053580.
2. Foundations of 3D Computer Graphics by S. J. Gortler, The MIT Press, 2012.
3. Fundamentals of Computer Graphics, 3rd Edition, A K Peters, 2009

CSC410 Mobile Application Development (3-0)

Contents:
Mobiles Application Development Platform; HTML5 for Mobiles; Android OS: Architecture, Framework and Application Development; iOS: Architecture, Framework; Application Development with Windows Mobile; Eclipse; Fragments; Calling Built-in Applications using Intents; Displaying Notifications; Components of a Screen; Adapting to Display Orientation; Managing Changes to Screen Orientation; Utilizing the Action Bar; Creating the User Interface; Listening for UI Notifications; Views; User Preferences; Persisting Data; Sharing Data; Sending SMS Messages; Getting Feedback; Sending Email; Displaying Maps; Consuming Web Services Using HTTP; Web Services: Accessing and Creating; Threading; Publishing, Android Applications; Deployment on App Stores; Mobile Programming Languages; Challenges with Mobility and Wireless Communication; Location-aware Applications; Performance/Power Tradeoffs; Mobile Platform Constraints; Emerging Technologies.

Text Book:
1. Professional Android application development, Reto Meier, Wrox Programmer to Programmer, 2015.
2. iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., 5th Edition, 2014.
3. Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., 2nd Edition, 2014.

CSC411 Open-Source Software Development (3-0)

Contents:
Fundamentals of Free and Open Source software development. Topics to be addressed include licensing, Linux, typical software development tools (e.g. compilers, scripting languages, build tools, and version control software), applications, and techniques x for managing remote servers. Students will work on a significant development project involving free and open-source software and learn how to participate in open-source projects effectively.

Text Book:
1. Open sources 2.0:the continuing evolution by Chris Dibona (2005)

CSC412 Advanced Programming Techniques (Pre Req: OOP) (3-0)

Contents:
Introduction to Events; Fundamentals of Event-driven Programming, message handling, user interfaces, graphics device interface, painting and drawing, windows management, input devices, resources, string and menu resource, dialogs and windows controls, common controls, dynamic link libraries, threads and synchronisation, network programming, Building Class Libraries at the Command Line, Class Libraries, Using References, Assemblies, Private Assembly Deployment, Shared Assembly Deployment, Configuration Overview, Configuration Files, Programmatic Access to Configuration, Using SDK Tools for Signing and Deployment, Metadata, Reflection, Late Binding, Directories, Files, Serialization, Attributes, Memory Management and Garbage Collection, Threading and Synchronization, synchronous Delegates, Application Domains, Marshal by Value, Marshal by Reference, Authentication and Authorization, Configuring Security, Code Access Security, Code Groups, Evidence, Permissions, Role-Based Security, Principals and Identities, Using Data Readers, Using Data Sets, Interacting with XML Data, Tracing Event Logs, Using the Boolean Switch and Trace Switch Classes, Print Debugging Information with the Debug Class, Instrumenting Release Builds with the Trace Class, Using Listeners, and Implementing Custom Listeners. Introduction to generic programming, Introduction to Standard template library, Advance pointers handling, and memory management.

Text Book:
1. Visual C#: How to Program, Deitel and Deitel, 6/e Edition, Prentice Hall / Pearson Education, 2017.
2. Programming in C# .NET, J.C. Bradley, A.C. Millspaugh, McGraw-Hill, 2014
3. Microsoft Visual C# 2013 Step by Step (Step by Step Developer), Sharp, J., 1st Edition (2013), Microsoft Press

CSC413 E-Commerce (3-0)

Contents:
An overview of E-Commerce & its business models and concepts, Planning an ECommerce Framework, Managing Products and Categories, Product Variations and User Uploads, Enhancing the User Experience, The Shopping Basket, The Checkout and Order Process, Shipping and Tax, Discounts, Vouchers, and Referrals, Checkout, Taking Payment for Orders, User Account Management, Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping, Deploying, Security, and Maintenance, Web Payment Systems, Social, Legal, and Ethical Issues of E-Commerce, Auctions, Portals, and Communities, SEO.

Text Book:
1. E-Commerce, Kenneth Laudon and Carol Guercio Traver, 13th Edition, Pearson, 2017.
2. PHP 5 E-commerce Development, Michael Peacock, Packt Publishing, 2010.
3. Introduction to E-Commerce, Jeffrey F. Rayport, McGraw-Hill, 2nd Edition, 2007.

CSC414 Enterprise Application Development (3-0)
Contents: Business functions, business processes, and functional areas of business operation, Data needs of each functional area of business, Data production by each functional area of business, Definition of integrated information system, What is an enterprise information system? What is enterprise resource planning (ERP)? History of ERP, Definition of Enterprise Resource Planning system, Modular nature of ERP systems, ERP pros, and cons, Current issues with respect to ERP implementation – security and privacy, global
Text Book: 1. Enterprises system for management by Luvai F.Mottiwala & Jeff Thompson (2nd edition, 2014)   2. Advanced Programming using visual basic 2008 by Julia Case Bradley, Anita C. Millspaugh

CSC415 Web Technologies (3-0)
Contents: This course will cover many of new and upcoming technology; Students will get hands-on practices on different technologies; this course covers Client Side Technologies; HMTL, JavaScript, AJAX, and Server Side Technologies; PHP, PHP, Web Services and Rich Internet Application Framework; FLEX Also they will get an introduction to upcoming technologies like Semantic Web
Text Book: 1. Web Application Architecture: Principles, Protocols, and Practices by Leon Shklar and Richard Rosen, Wiley; 2nd Edition (May 5, 2009). ISBN-10:047051860X   2. Web Technologies: A Computer Science Perspective by Jeffrey C. Jackson, Prentice Hall; 1st Edition (August 27, 2006). ISBN-10:0131856030

CSC420 Object Oriented Analysis and Design (3-0)
Contents: This course requires prior experience in object oriented programming and familiarity with basic object oriented concepts such as abstraction, encapsulation, inheritance, composition, aggregation. Object oriented analysis and design concept are introduced using UML, and iterative evolutionary design process based on the unified process applied in the agile spirit. Students will also learn application of object oriented design principles and patterns such as GRASP and GOF Design patterns.
Text Book: 1. Applying UML and patterns: An introduction to Object-Oriented Analysis and Design and Iterative Development by Craig Larman, Prentice Hall; 3rd Edition (October 30, 2004). ISBN-

CSC420 Object Oriented Analysis and Design (3-0)

10: 0131489062
2. Using UML: Software Engineering with Objects and Components by Perdita Stevens, Addison-Wesley; 2nd Edition (February 13, 2006). ISBN-10: 0321269675
3. Fundamental of Object-Oriented Design in UML by Meiler Page-Jones, Addison Wesley, 2000. ISBN: 020169946X.
4. The Unified Modeling Language User Guide by G. Booch, J. Rambaugh and I. Jakobson, Addison-Wesley Professional; 2nd Edition (2005). ISBN- 10:0321267974.

CSC421 Design Patterns (3-0)

Contents:
This course is an introduction to software design patterns. Each pattern represents a best practice solution to a software problem in some context. The course will cover the rationale and benefits of object-oriented software design patterns. Several example problems will be studied to investigate the development of good design patterns. Specific patterns, such as Observer, State, Adapter, Strategy, Decorator, and Abstract Factory will be discussed. Programming projects in the Java language will provide experience in the use of these patterns. In addition, distributed object frameworks, such as RMI, will be studied for their effective use of design patterns.

Text Book:
1. Gamma, et. Al., Design Patterns - Elements Of Reusable Object-Oriented Software, Addison-Wesley, 1995

CSC422 Management Information Systems (3-0)

Contents:
This course helps you to understand what IT components are available and how you can utilize appropriate IT applications for success. You will learn the terminology used in the field of IT and how IT principles can apply to your businesses. The course stresses the competitive advantage of using IT and the return on investment that you can see. It focuses on the basic principles of Information Technology: hardware and software components, database technology, telecommunications and networking, e-commerce and e-business, Enterprise Resource Planning (ERP), Decision Support Systems (DSS), Artificial Intelligence (AI) and Expert Systems (ES), systems development and implementation, and the ethical and societal issues involved in IT.

Text Book:
1. Experiencing MIS, D. M. Kroenke, A. Gemino and P. Tingling. P. 4th Edition. Toronto: Pearson.2016.
2. Business driven information systems, P. Baltzan, B. Detlor, and C. Welsh, 4th Ed., McGraw Hill Ryerson Press, 2015.

CSC423 Intro to Program Analysis (3-0)
Contents: Advanced techniques for statically analyzing programs are discussed. These techniques allow one to answer computationally hard questions about programs in an efficient albeit on servative way. They are also referred to as abstract interpretation since the algorithms interpret the program on a simplified abstract domain. The techniques are useful in compilers in order to generate more efficient code and in other programming language environments such as debuggers and code quality checkers
Text Book: 1. Flemming Nielson, Hanne Riis Nielson, and Chris Hankin. 2. Principles of Program Analysis (Springer Publishing Company, Incorporated ©2010 ISBN:3642084745 9783642084744)

CSC424 Formal Methods (3-0)
Contents: Design-by-contract (DBC): Information flow analysis, oof of correctness, dels of software designs, Fundamentals of software specification; specifically, how to be abstract without being imprecise. Specification paradigms: Contracts (e.g., SPARK Ada), Model-based techniques (e.g., Alloy), (time permitting) Action languages and notations for reasoning about concurrency (e.g., FSP), (time permitting) Temporal logics (e.g., PTL and GIL), Formal refinement, Automated analysis of behavioral specifications
Text Book: Concise Guide to Formal Methods Theory, Fundamentals and Industry Applications Authors: O'Regan, Gerard (© 2017 , ISBN 978-3-319-64021-1)

CSC425 Leading Software Teams (3-0)
Contents: The importance of creating meaning in personal and professional lives of Software Developer. The importance of leadership in the fulfillment of this meaning in Software Developers' lives. The four basic elements of leadership include character for Software Project Development. Introduction to the meaningful life framework for Software Developers. A couple of case studies of individuals who have demonstrated exemplary leadership. The art of negotiation comes into play daily in the life of employees at all levels and in every position. Participants explore how current approaches to negotiation strategy and tactics are used, what negotiation entails, types of negotiation relationships that exist from hard bargaining to win-win, to fully partnered relationships and personal ones.

CSC425 Leading Software Teams (3-0)

Text Book:
1. The Leaders Eat Last by Simon Sinek Edition: Unabridged Edition, Year: 2017, Publisher: Brilliance Audio
2. The Sealed Nectar by Safiur Rahman Mubarakpuri Edition: English Edition, Year: 2008, Publisher: Dar-us-Salam Publications The Last Mughal (Willam Dalrymple) Edition: 58459th, Year: 2008, Publisher: Vintage
3. The Art of Negotiation: How to Improvise Agreement in a Chaotic World by Michael Wheder Edition: Abridged Edition, Year: 2011, Publisher: Brilliance Audio

CSC426 Habits of Highly Effective Software Engineer (3-0)

Contents:
First, we introduce the concepts of vision, purpose, balance, and leadership. Technical definitions of the terms vision, mission, purpose, purpose of the vision, ultimate purpose, strategy, and goals; The seven functions of vision; The nine characteristics of vision; Introduction to the concept of excellence; The concept of striking a balance between all our roles. Importance of Vision in Software Development. As a guide to prioritizing all our activities, we teach the Eisenhower Grid, later refined by Stephen Covey as Time Quadrants, which classifies all activities in our software development life cycle according to their importance and urgency. In the Second module, we explain the significant role our will and determination have in the execution and successful implementation of our decisions during software development. Lastly, we connect all the covered concepts for providing you with a powerful game plan to manage your time and organize your life.

Text Book:
1. 4-Hour Week by Tim Ferriss Edition: Expanded, Updated Edition, Year: 2015, Publisher: Harmony
2. The Productive Muslim by Muhammad Faris Edition: 1st , Year: 2016, Publisher: Claritas Books Strategic Time Management by Sulamn Ahmer (Video Lectures)

CSC427 Personal, Team, and Executive Software Processes (3-0)

Contents:
In this course, you learn the foundational concepts of the Personal Software Process (PSP) and Team Software Process (TSP). the course teaches you to measure size, time, and defects in your work; how to use a personal planning framework to plan and track your tasks; and how to use a quality strategy to manage defects in your work and be prepared to participate in a TSP team. TSP launch process; how to be a productive participant in a launch; how to use weekly meetings, inspections, checkpoints, and postmortems to manage and maintain self-directed teams; and more.

CSC427 Personal, Team, and Executive Software Processes (3-0)

Text Book:
1. Introduction to the Team Software Process 1st Edition by Watts S. Humphrey (Author)
2. PSP: A Self-improvement Process For Software Engineers 1st Edition by Watts S. Humphrey (Author)

CSC430 Database Backup & Recovery (3-0)

Contents:
This course provides an introduction to database backup, restore, and recovery using Oracle 12c. You will study the critical tasks of planning and implementing database backup and recovery strategies. The course explores backup methodologies based on business requirements in a typical enterprise and utilizes multiple strategies to recover from different types of recovery failures. This course also introduces students to Oracle network concepts and
administration. Students will access an Oracle instance located on the Academic Research Network (ARNe) via Citrix over the Internet.

Text Book:
1. Kuhn, D., Alapati, S., Nanda, A. (2013). RMAN Recipes for Oracle Database 12c: A
2. Problem-solution Approach. New York, NY: APRESS. ISBN: 978-1430248361.
3. Coronel, C., Morris, S. & Rob, P. (2013). Database Systems: Design, Implementation, and
4. Management (10th ed.). New York, NY: Thompson. ISBN: 9781111969608.

CSC431 Distributed Databases (3-0)

Contents:
First, we introduce distributed DBMS, Promises Of Distributed Database Systems, Parallel Systems, why Distributed Database, and Distributed DBMS Architecture. In the second module, we study classical distributed database management issues such as distribution design, distributed query processing and optimization, and distributed transaction management. In the last module, we study more current distributed database management topics such as pervasive computing, Web data management, different distribution models (push versus pull), interoperability and componentization, and data mining on the web

Text Book:
1. Principles of Distributed Database Systems 3rd edition, Authors: Özsu, M. Tamer, Valduriez, Patrick, © 2011 (by Springer)
2. K.R. Dittrich and A. Geppert, Component Database Systems, Morgan-Kaufman, 2001.
3. J. Han and M. Kamber, Data Mining - Concepts and Techniques, Morgan-Kaufman, 2001.

CSC432 Graph Databases (3-0)

Contents:
OPTIONS FOR STORING CONNECTED DATA: Why Relational Databases Aren''t Enough, How NoSQL Databases Lack Relationships, How Graph Databases Embrace Data Relationships. DATA MODELING WITH GRAPHS: The Labeled Property Graph, An Introduction to the Cypher Query Language, Relational vs. Graph Data Modeling. BUILDING A GRAPH DATABASE APPLICATION: Application Architecture, Capacity Planning, Importing and Loading Bulk Data. PREDICTIVE ANALYSIS WITH GRAPH DATABASES: Graph Theory and Predictive Modeling, Depth- and Breadth-First Search, Path-Finding with Dijkstra''s Algorithm

Text Book:
1. Graph Database by Ian Robinson, Jim Webber & Emil Eifrem Edition: 2nd, Year: 2015, Publisher: O'Reilly Media

CSC433 Database Administration (3-0)

Contents:
Oracle Database Architecture, Database Installation, Creating Database Using DBCA, Database Instances, ASM Instances, Network Environment, Storage Structures, User Security, Concurrency Control Mechanisms, Database Auditing and Maintenance, Performance Management, Backup and Recovery Concepts, Moving Data, Database Restart. The whole content will be explained in the Oracle environment and students will have the right to take Oracle Database 11g: Administration I 1Z0- 052 exam as part of the Oracle Academy membership and be able to take Oracle Database 11g Administrator Certified Associate (OCA)

Text Book:
1. Database Administration: The Complete Guide to DBA Practices and Procedures, Second
2. Edition, Craig S. Mullins, 2010
3. Student Guides for Oracle Database Administration. Year/Edition: 2010 Aug Title: Oracle
4. Database 11g: Administration Workshop 1 (Volume 1 and 2)

CSC434 Database Performance & Optimization (3-0)

Contents:
SQL Server Architecture, Scheduling, and Waits, SQL Server I/O, Database Structures, SQL Server Memory, Concurrency and Transactions, Statistics and Index Internals, Query Execution and Query Plan Analysis, Plan Caching and Recompilation, Extended Events, Monitoring, Tracing, and Baselining, Troubleshooting Common Performance Issues

Text Book:
1. Database Performance Tuning and Optimization: Using Oracle Softcover reprint of the

CSC434 Database Performance & Optimization (3-0)
original 1st ed. 2003 Edition by Sitansu S. Mittra (Publisher: Springer; Softcover reprint of the original 1st ed. 2003 edition (May 3, 2013) Language: English ISBN-10: 1475776977)

SE-211 Software Requirements Engineering (3-0)
Contents: Introduction to Requirements Engineering, Software Requirements, classification of requirements, Requirements process, Levels/layers of requirements, Requirement characteristics, Analyzing quality requirements, Software requirements in the context of systems engineering, Requirement evolution, requirement traceability, requirement prioritization, trade-off analysis, risk analysis and impact analysis, Requirement management, interaction between requirement and architecture, Requirement elicitation, elicitation sources and techniques, Requirement specification and documentation, specification sources and techniques, Requirements validation and techniques, Management of Requirements, Introduction to Management, Requirements Management Problems , Managing Requirements in an Acquisition Organization, Supplier Organizations, Product Organizations, Requirements engineering for agile methods.
Text Book: 1. Software Requirements, Wiegers K. &Beatty J., 3rd Ed. Microsoft Press, 2013 2.Requirements Engineering, Elizabeth Hull, Ken Jackson, and Jeremy Dick. 3rd Ed, Springer-Verlag London Limited, 2011. 3. Requirements Engineering and Management for Software Development Projects, Chemuturi M., Springer New York, 2013.

SE-222 Software Design & Architecture (3-0)
Contents: Software Design Concepts, Design principles, Object-Oriented Design with UML, System design and software architecture, Object design, Mapping design to code, User interface design, Persistent layer design, Web applications design, State machine diagrams and modeling, Agile software engineering, Design Patterns, Exploring inheritance, Interactive systems with MVC architecture, Software reuse. Architectural design issues, Software Architecture, Architectural Structures & Styles-, Architectural Patterns, Architectural & Design Qualities, Quality Tactics, Architecture documentation, Architectural Evaluation, Model driven development.
Text Book: 1. Engineering: A Practitioner's Approach, Roger S. Pressman, Bruce R. Maxim, 8th Ed, McGraw-Hill Education, 2015. 2. Object-Oriented Analysis, Design and Implementation, Brahma Dathan, Sarnath Ramnath, 2nd Ed, Universities Press, India, 2014.

SE-222 Software Design & Architecture (3-0)
3. Software Modeling and Design: UML, Use Cases, Patterns, and Software Architectures, Hassan Gomaa, Cambridge University Press, 2011.

SE-323 Software Construction and Development (3-0)
Contents: Software development process, Software engineering process infrastructure, Software engineering process improvement, Systems engineering life cycle models, Process implementation, Levels of process definition, Life cycle model characteristics, Individual and team software process, Lehman's Laws, code salvaging, and configuration management. Martin Fowler's refactoring concepts and their application to small projects. Apply Michael Feathers' "legacy code" concepts. Exception handling, makes methods robust by having them check their inputs sent from calling objects. Software configuration management, Release management, Software configuration management processes, Software deployment processes, Distribution and backup, Evolution processes and activities, Basic concepts of evolution and maintenance, Working with legacy systems, Refactoring, Error handling, exception handling, and fault tolerance. Personal reviews (Design, code, etc.), Peer reviews (inspections, walkthroughs, etc.).
Text Book: 1. Clean Code: A Handbook of Agile Software Craftsmanship, Robert C. Martin, Prentice Hall, 2008. 2. The Pragmatic Programmer: From Journeyman to Master, Andrew Hunt and David Thomas, Addison-Wesley Professional, 1999. 3. Working Effectively with Legacy Code, Michael C. Feathers. Pearson Education, Prentice-Hall, 2004.

SE-324 Principles of Web Engineering (3-0)
Contents: Web programming languages (e.g., HTML5, CSS 3, Java Script, PHP/JSP/ASP.Net), Design principles of Web-based applications, Web platform constraints, Software as a Service (SaaS), Web standards, Responsive Web Design, Web Applications, Browser/Server Communication, Storage Tier, Cookies and Sessions, Input Validation, Full stack state management, Web App Security - Browser Isolation, Network Attacks, Session Attacks, Large scale applications, Performance of Web Applications, Data Centers, Web Testing and Web Maintenance.
Text Book: 1. Web Engineering, Rajiv Chopra, Prentice-Hall of India, 2016 2. Web Engineering, Emilia Mendes and Nile Mosley, Springer Verlag, 2010. 3. Web Engineering: A Practitioners' Approach, Roger S. Pressman, McGraw Hill, 2008.

SE-325 UX/UI Design (3-0)

Contents:
Designing for multi-device environments, What you need to master, What are you trying to communicate?, Why is user experience important?, Identify the project parameters, Brand presence, Marketing campaign, Content source, eCommerce applications, Social networking applications Responsive considerations, Creating the proposal, Title page, Executive summary, Project outline and approach, Assumptions, Deliverables, Project scoping, Legal considerations, Pricing and payment structures, Statements of work, Status quo analysis, Heuristic analysis, Stakeholder input, Roles and responsibilities, Consolidating outcomes

Text Book:
The Elements of user experience by Jesse James Garred (2nd edition, 2011)

SE-331 Software Quality Engineering (3-0)

Contents:
Software Quality, Software Quality Attributes, Quality Engineering., Testing: Concepts, Issues, and Techniques, Software testing lifecycle., Testing Scopes, Testing Approaches, Testing Concepts, Test Planning Process, Introduction to testing process, Requirement of software test planning, Testing documentation, Reporting and historical data recording., Software testing techniques, Testing philosophies, Testing strategies, Model based testing, Software testing techniques, Testing using models, Domain and combinatorial testing, Unit and integration testing, Acceptance testing, Test automation, Slicing, Software reliability models and engineering, Introduction, Exponential model, Reliability growth models, Modeling process, Software inspections, Software reviews, Inspection checks and metrics, Quality Models, Models for quality assessment, Product quality metrics, Quality Measurements, In-Process metrics for software testing, In-Process quality management, Effort/outcome models, System testing, Introduction to sub-system testing, From functional to system aspects of testing, System testing, Introduction to system testing, Scenarios development, System testing, Use-cases for testing, Specification-based testing, Open issues on software testing

Text Book:
1. Paul Jorgensen, Software Testing, A Craftsman's Approach, 4th Ed. CRC Press, Taylor and Francis Group, 2015
2. Bernard Homes, Fundamentals of Software Testing, ISTE, Wiley, 2012
3. Software Engineering, "Ian Sommerville, 9th Edition, Addison Wesley, 2011

SE-332 Software Measurement & Metrics (3-0)

Contents:
Introduction to quality control and planning needs (Measurement Concepts, Measurement as a

SE-332 Software Measurement & Metrics (3-0)

support process, Review Metrics Models and Standards). Measurement goals (Formulating problem and goal statement, Prioritize information needs and objectives, Formalize measurement goals). Specify Measures (Identify questions and indicators, Identify data elements and Operational definitions for measures). Specify Data Collection and Storage Procedures. Sources of data. How to collect and store the measurement data? Specify Analysis Procedures. Potential data analyses. Methods and tools for measuring software. Develop software measurement reporting. Current research topics in Software Measurement and Metrics.

Text Book:
1. Metrics and Models in Software Quality Engineering, Stephen H. Kan, Addison Wesley, 2003
2. Measuring the Software Process, Anita Carleton, William A. Florac, Addison-Wesley 1999
3. The Big Book of Six Sigma training Games, Chris Chen and Hadley Roth, McGraw-Hill, 2005

SE-341 Software Project Management (3-0)

Contents:
Introduction to Software Project Management, Project Management concepts, Project Management Tools, PMI's Knowledge areas, PMI Framework, PMI Process Groups. Understanding Organizations. Project Planning, Project Evaluation, Selection of an Appropriate Approach to the Project, Software Effort Estimation, Activity Planning, Risk Management, Evaluating the Risks to the Schedule, Risk Control, Configuration Management and Maintenance, Environment for Configuration Control, Resource Allocation, Monitoring & Control, Review and Evaluation, Challenges of Outsourcing in Project Management

Text Book:
1. Software Project Management, Bob Hughes and Mike Cotterell, McGraw-Hill Education; 5th Edition (2009).
2. A Guide to the Project Management Body of Knowledge, 5th Edition (PMBOK Guides),
3. Mastering Software Project Management: Best Practices, Tools and Techniques, Murali K. Chemuturi and Thomas M. Cagley Jr., J. Ross Publishing, 2010

SE-442 Software Re-Engineering (3-0)

Contents:
Salient topics include the terminology and the processes pertaining to software evolution, fundamental re-engineering techniques to modernize legacy systems including source code analysis, architecture recovery, and code restructuring, software refactoring strategies, migration to Object Oriented platforms, quality issues in re-engineering processes, migration to network-centric environments, and software integration, reverse engineering, program comprehension, source code transformation and refactoring strategies, software maintenance and re-engineering

SE-442 Software Re-Engineering (3-0)

economics.

Text Book:
1. Re-engineering legacy software, David Lorge Parnas, Chris Birchall, Safari Books, Shelter Island, NY, 2016
2. Reengineering, Priyadarshi Tripathy and Kshirasagar Naik, John Wiley & Sons, Inc.2015
3. Software Maintenance and Evolution: a Roadmap, K.H.Bennett and V.T Rajlich, The Future of Software Engineering, ACM Press 2000.

SE-453 Software Engineering Economics (3-0)

Contents:
Programming aspects, economic aspects, human relations aspects, software trends: cost, social impact, the plurality of SE Means, The GOALS Approach to Software Engineering, The Software Work Breakdown Structure (WBS), Software Maintenance, introduction to COCOMO, definitions and assumptions, development effort and schedule, phase distribution, The Rayleigh Distribution, interpolation, basic software maintenance effort estimation. Performance Models, Optimal Performance, Sensitivity Analysis, Cost- Effectiveness Models. Cost Drivers: Project Attributes–Modern Programming Practices, Use of Software Tools, Schedule Constraint.

Text Book:
1. Software Engineering Economics and Declining Budgets by Pamela T. Geriner, Thomas R. Gulledge, William P. Hutzler, Springer Verlag, 2012
2. Estimating Software Costs: Bringing Realism to Estimating, Capers Jones, McGraw- Hill Osborne Media; 2nd Edition, 2007.
3. Software Cost Estimation and Sizing Methods, Issues, and Guidelines, Shari Lawrence Pfleeger, Rand Publishing, 2005.

SE-454 Topics in Software Engineering (3-0)

Contents:
In this course, a multitude of topics are covered. List of topics to be included are: Component-Based Software Engineering, Service Oriented Architecture, Design and Development of Frameworks, Aspect Oriented Programming, Team Management Frameworks, Lean Software Development, Configuration Management, Software Change Management, Software Product Management, Software Deployment and Maintenance Management, Advancing Organizational Capability: Applying CMMI, Automated Software Testing, Software Testing Framework (Selenium/Appium), Software Performance Testing. Other topics may be added based on modern trends.

SE-454 Topics in Software Engineering (3-0)
Text Book: 1. Bourque, P. and Fairley, R.E., Eds. (2014) "Guide to the Software Engineering Body of Knowledge" [Electronic version], Version 3.0, IEEE Computer Society, Retrieved April 22, 2020, from https://www.computer.org/web/swebok.

CSC350 Programming for AI (3-0)
Contents: Contents   Application of Artificial Intelligence in Uncertain Environments: Quantifying Uncertainty, Probablisitic Reasoning, Probablisitic Reasoning Over Time,Making Simple Decisions,Making Complex Decisions, Learning Probablistic Models, Reinforcement Learning. Application of Artificial Intelligence in Natural Language Processing, Vision, and Bussiness.
Text Book: 1. Artificial Intelligence A Modern Approach Third Edition, Stuart J. Russell and Peter Norvig. 2. Artificial Intelligence In Practice: How 50 Successful Companies Used Artificial Intelligence To Solve Problems, Bernard Marr

CSC351 Machine Learning (3-0)
Contents: Introduction to machine learning and statistical pattern recognition. Supervised learning: Part I (Graphical models (full Bayes, Naïve Bayes), Decision trees for classification & regression for both categorical & numerical data, Ensemble methods, Random forests, Boosting (Adaboost and Xgboost), Stacking; Part II (Four Components of Machine Learning Algorithm Hypothesis, Loss Functions, Derivatives and Optimization Algorithms), Gradient Descent, Stochastic Gradient Descent, Linear Regression, Nonlinear Regression, Perceptron, Support vector machines, Kernel Methods, Logistic Regression, Softmax, Neural networks); Unsupervised learning: K-means, Density Based Clustering Methods (DBSCAN, etc.), Gaussian mixture models, EM algorithm, etc.; Reinforcement learning; Tuning model complexity; Bias-Variance Tradeoff; Grid Search, Random Search; Evaluation Metrics; Reporting predictive performance
Text Book: 1. Elements of Statistical Learning 2. Pattern Recognition & Machine Learning, 1st Edition, Chris Bishop 3. Machine Learning: A Probabilistic Perspective, 1st Edition, Kevin R Murphy

CSC352 Introduction to Deep Learning (3-0)

Contents:
Introduction to Deep learning, Review of Linear classification (Multi-class Support Vector Machines, Soft max) and Regularization, Gradient Descent & Stochastic Gradient Descent (SGD), Back propagation (Intuitions, back propogation as flow graph), Introduction to Neural Networks (model of a biological neuron, activation functions, neural net architecture, representational power, etc.), Building Neural Networks (data preprocessing, loss functions, weight initialization, regularization, dropout, batch normalization), Learning Neural Networks (Learning and Evaluation gradient checks, sanity checks), Variants of SGD (momentum, Adagrad/RMSprop, ADAM), Introduction to Convolutional Neural Networks (CNN) and its components (Convolution and Pooling Layers), Convolutional Neural Network case studies (AlexNet/ZFNet/VGGNet), Understanding and Visualizing Convolutional Neural Networks, Convolutional networks for other visual Recognition Tasks (Localization, Detection, Segmentation, etc.), Transfer Learning and Fine-tuning Convolutional Neural Networks, Introduction to Natural Language Processing (NLP), Learning word and sentences embedding (wordvec, glove, sentvec), Introduction to recurrent networks (RNNs, LSTMS, etc.), Applications of Recurrent neural networks to different NLP tasks (e.g. sentiment analysis, parsing, NER tagging, etc.), Introduction to Reinforcement Learning and QLearning, Deep Q-Networks (DQN) and Game playing using DQN, Introduction to Policy gradients and their applications

Text Book:
1. Deep Learning, 1st Edition, Yoshua Bengio, Ian Goodfellow, Aaron Courville, Neural networks and deep learning, 1st Edition, Michael A. Nielsen
2. Hands-On Machine Learning with Scikit-Learn and Tensor Flow, 1st Edition, Aurélien Géron

CSC353 Knowledge Representation and Reasoning (3-0)

Contents:
Propositional Logic, First-order Logic, Horn Clauses, Description Logic, Reasoning using Description Logic, Forward and Backward Chaining in Inference Engines, Semantic Networks, Ontologies and Ontology Languages, Logical Agents, Planning, Rule-based Knowledge Representation, Reasoning Under Uncertainty, Bayesian Networks Representation, Inference in Bayesian Networks, Fuzzy Logic, Inferene using Fuzzy Rules, Markov Models, Commonsense Reasoning, Explainable AI.

Text Book:
1. Stuard Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (3rd Ed.) (2015)
2. David Poole and Alan Mackworth, Artificial Intelligence: Foundations of Computational Agents, 2nd Ed, 2017
3. Ronald Brachman and Hector Levesque. Knowledge Representation and Reasoning, 2004

CSC354 Computer Vision and Image Processing (3-0)

Contents:
Computer Vision aims to extract descriptions of the world from pictures or video. In recent years, much progress has been made on this challenging problem. This course is divided into two parts. The first part will introduce basic computer vision concepts. It will then move onto mid-level problems such as tracking and segmentation. Second part will give details about state of the art applications of computer vision such as detecting object classes (e.g. car, table, chair) in images, human action and emotion recognition (walk, run, sad, happy).

Text Book:
1. Szeliski, Richard, Computer Vision: Algorithms and Applications Springer, 2011.
2. Forsyth, David A., and Ponce, J. Computer Vision: A Modern Approach, Prentice Hall, 2003.

CSC450 Philosophical Foundations of AI (3-0)

Contents:
Research in the field of Artificial Intelligence (AI) is developing at a rapid pace. The philosophy of artificial intelligence is a collection of issues primarily concerned with whether or not AI is possible, with whether or not it is possible to build an intelligent thinking machine. Also, of concern is whether humans and other animals are best thought of as machines (computational robots, say) themselves. This course will cover the history of artificial intelligence and philosophical issues that emerge out of the development of current and future AI systems. It includes problem solving by searching, communicating, perceiving and acting. It is divided into three sections: (1) classic philosophical history of AI (2) AI algorithms and (3) Future of AI Systems

Text Book:
1. Russell, Norvig. Artificial intelligence: A modern approach, 2nd edition. Pearson/Prentice Hall.
2. Artificial Intelligence: Structures and Strategies for Complex Problem Solving

CSC451 Natural Language Processing (3-0)

Contents:
Deterministic and stochastic grammars, Parsing algorithms, CFGs, Representing meaning Semantics, Semantic roles, Temporal representations, Corpus-based methods, N-grams and HMMs, Smoothing and backoff, POS tagging and morphology, Information retrieval, Vector space model, Precision and recall, Information extraction, Language translation, Text classification, categorization, Bag of words model.

CSC451 Natural Language Processing (3-0)

Text Book:
1. Python Machine Learning, Sebastian Raschka. Publisher: Packt Publishing, 2015.
2. Natural Language Processing with Python: Analyzing Text with the Natural Language Toolkit Latest Edition, Steven Bird, Ewan Klein and Edward Loper Publisher: O'Reilly Media, 2009.
3. Speech and Language Processing, Latest Edition, Daniel Jurafsky, and James H. Martin Publisher: Prentice Hall, 2000

CSC452 Speech Processing (3-0)

Contents:
This course will introduce the fundamentals of speech processing. The topics include periodic vs. aperiodic waves, resonance, standing waves, complex waves, spectrum; speech signal, source-filter theory of speech production, glottal waveform, acoustic properties of vowels and consonants, acquisition of speech signal, A/D conversion including quantization and sampling, filtering and amplification; time-domain speech analysis, framing, zero-crossing rate, short-term energy, speech segmentation, frequency domain representation, windowing, Fourier transforms, parameterization of speech, autocorrelation, linear prediction including autocorrelation method, covariance method, applications of LPC including vocal tract area estimation, pitch calculation, formant estimation, cepstral analysis and applications including pitch extraction, speech recognition and speech synthesis.

Text Book:
1. Books on Google Play Theory and Applications of Digital Speech Processing Front Cover Lawrence R. Rabiner, Ronald W. Schafer
2. Introducing Speech and Language Processing By John S. Coleman
3. Speech and Language Processing, Latest Edition, Daniel Jurafsky and James H. Martin Publisher: Prentice Hall, 2000.

CSC453 Soft Computing (3-0)

Contents:
The goal of Soft Computing is to develop intelligent machines to provide solutions to real world problems, which are not modeled, or too difficult to model mathematically. Core topics of Soft Computing include Fuzzy Logic, Neural computing, Evolutionary computation/Genetic Algorithms, Machine learning and probabilistic reasoning etc.

Text Book:
1. Fuzzy Control: Theory and Practice by Rainer Hampel (Editor), Michael Wagenknecht (Editor), Nasredin Chaker (Editor) Edition: 2000 edition, Year: 2000, Publisher: Physica

CSC453 Soft Computing (3-0)
2. Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence by Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani Edition: 1st, Year: 1997, Publisher: Pearson

CSC454 Agent-Based Modelling (3-0)
Contents: Introduction to agent based modeling. Introduction to Net Logo. Complexity in Social Worlds. Net Logo Commands. Net Logo Procedures. Model properties (Why agentbased objects? Agents, environments, and timescales).Biological systems: fireflies, flocking, slime mold, bees, ants (flocking behavior slime mold).Biological systems: predator/prey, debugging (Verification and validation).Social systems: segregation, Schelling, Micro motives and Macro behavior. A self-forming neighborhood model. Cellular automata. Critical phenomena. Sand piles. Current research topics in Agent Based Modeling.
Text Book: 1. Agent-Based Models, Nigel Gilbert, SAGE Publications, 2008

CSC455 Logical Paradigms of Computing (3-0)
Contents: Propositional logic, Declarative sentences, Natural deduction, Propositional logic as a formal language, Semantics of propositional logic, Normal forms. Predicate logic, The need for a richer language, Predicate logic as a formal language, Proof theory of predicate logic, Semantics of predicate logic, Un-decidability of predicate logic, Expressiveness of predicate logic, Micro models of software, Verification by model checking, Motivation for verification, Linear-time temporal logic LTL Model checking: systems, tools, properties, Branching-time logic CTL, CTL* and the expressive powers of LTL and CTL, Model-checking algorithms. The fixed-point characterization of CTL, Program verification, Why should we specify and verify code? A framework for software verification, Proof calculus for partial correctness, Proof calculus for total correctness, Programming by contract, Modal logics and agents, Modes of truth, Basic modal logic, Logic engineering. Natural deduction, Reasoning about knowledge in a multi-agent system, Binary decision diagrams, Representing Boolean functions, Algorithms for reduced OBDDs, Symbolic model checking. A relational mu-calculus. Introduction to Process Algebra, Modelling Communication, Synchronization, Action and Transition Internal Actions.
Text Book: 1. Logic in Computer Science Modelling and Reasoning about Systems 2nd Edition Michael Huth, Mark Ryan, University of Birmingham, 2004 2. Principles Of Model Checking by Christel Baier and Joost-Pieter Katoen MIT Press, 2008 3. Software Reliability Methods Doron Peled, Springer, 2001

CSC456 Simulation and Modelling (3-0)

Contents:
Introduction to modelling and simulation, System analysis, Classification of systems, System theory basics, its relation to simulation, Model classification at conceptual, abstract, and simulation models levels, Methodology of model building, Simulation systems and languages, Means for model and experiment description, Principles of simulation system design, Parallel process modeling using Petri nets and finite automata in simulation, Models of queuing systems, Discrete simulation models, Model time, Simulation experiment control, Overview of numerical methods used for continuous simulation. System Dymola/ Modelica, Combined simulation, Special model classes, Models of heterogeneous systems, Cellular automata and simulation, Checking model validity, Verification of models, Analysis of simulation results, simulation results visualization, model optimization, generating, transformation, and testing of pseudorandom numbers with overview of commonly used simulation systems

Text Book:
1. Modeling and Simulation, Bungartz, H.-J., Zimmer, S., Buchholz, M., Pflüger, D., Springer-Verlag, 2014.
2. Simulation Modeling Handbook, A Practical Approach, Christopher A. Chung, CRC Press, 2004.
3. System design, modeling and simulation using Ptolemy II, Claudius Ptolemaeus, , Ver 2.0, Creative Commons Attribution-ShareAlike 3.0 Unported, 2014

CSC457 Web Semantics (3-0)

Contents:
Introduction to the semantic web, introduction to ontologies, ontology languages for the semantic web, Resource Description Framework (RDF), lightweight ontologies: RDF Schema, Web Ontology Language (OWL), query language for RDF: SPARQL, Ontology Engineering, Semantic web and Web 2.0 and applications of Semantic Web.

Text Book:
1. Build Flexible Applications with Graph Data, Toby Segaran, Colin Evans, Jamie Taylor,302 pages O'Reilly Media, 2009
2. Foundations of Semantic Web Technologies, Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph,
3. Introduction to the Semantic Web and Semantic Web Services, Liyang Yu, Chapman and Hall/CRC, 2007

CSC458 Information Retrieval (3-0)
Contents: Basic and advanced techniques for information systems: information extraction; efficient text indexing; indexing of nontext data; Boolean and vector space retrieval models; evaluation and interface issues; XML, structure of Web search engines; clustering, classification; spectral methods,random indexing; data mining
Text Book: C. D. Manning, P. Raghavan and H. Schütze: Introduction to Information Retrieval,Cambridge University Press, (Latest version). Edition: 2nd , Year: 2008, Publisher: Cambridge University Press New York

CSC459 Introduction to Bioinformatics (3-0)
Contents: The objective of this course will be to introduce students to the fundamentals of evolution, molecular biology, and molecular evolution. This course also aims to provide students with a practical and hands-on experience with common bioinformatics tools and databases. It would be expected that after completing this course a student would have a good working knowledge of basic bioinformatics tools and databases such as GenBank, BLAST, multiple alignment, and phylogenetic tree construction. Further students will understand the basic theory behind these procedures and be able to critically analyze the results of their analysis using such tools.
Text Book: 1. Bryan Bergeron M.D: Bioinformatics Computing, 2010.

CSC370 Fundamentals of Cyber Security (Pre Req Info. Security) (3-0)
Contents: Basic security concepts, Information security terminology, Malware classifications, Types of malware. Server side web applications attacks. Cross-site scripting, SQL Injection, Cross-site request forgery, Planning and policy, Network protocols and service models. Transport layer security, Network layer security, Wireless security, Cloud & IoT security.
Text Book: 1. Security+ Guide to Network Security Fundamentals by Mark Ciampa, th Edition 2. Corporate Computer Society by Randall J.Boyle, 3rd Edition

CSC371 Information Assurance (3-0)

Contents:
Introduction to (IS) Information System (Concept, Design, Functions, Architecture, Components and applications of IS); Secure System Planning and Administration; Information Security Policies and Procedures; Asset Management; Organizational and Human Security; Cyber Security Management Concepts; NIST Cyber Security Framework; Enterprise Roles and Structures; Strategic Planning; Security Plans and Policies; Contingency Planning; Laws; Laws and Regulatory Requirements; Security Standards and Controls, Risk Management Process, NIST Risk Management Framework, Security Metrics and Key Performance Indicators (KPIs); Physical Security and Environmental Events; Contingency Planning; Security Education, ISO 27001 Compliance, Training, and Awareness.

Text Book:
1. Principles of Information Security by Michael E. Whitman, 6th Edition, 2017
2. Reference Material: CISSP Study Guide, 7th Edition
3. Information Assurance: Managing Organizational IT Security Risks by Joseph Boyce and Daniel Jennings, 1 Edition or Latest

CSC372 Network Security (3-0)

Contents:
Introduction to network security, Networking Concepts and Protocols, Network Threats and Vulnerabilities, Network Security Planning and Policy, Access Control, Defense against Network Attacks, DOS and DDOS detection and prevention, Firewalls, Intrusion Detection and Prevention Systems, Antivirus Filtering, Naming and DNS Security, DNSSEC, IP security, Secure Sockets Layer, VPN, Packet Sniffing and spoofing, Honeypot, Ethernet Security, Wireless Security, Wireless Attacks, Wireless LAN Security with 802.11i, Wireless Security Protocols, Wireless Intrusion Detection, Physical access and Security, Tor Network, Network Forensics. Defense against Network Attacks.

Text Book:
1. Network Security Assessment: Know Your Network by Chris McNab, 3rd Edition or latest
2. Corporate Computer Security, by Randall J. Boyle, 3th Edition
3. Bulletproof Wireless Security by Praphul Chandra

CSC373 Secure Software Design and Development (3-0)

Contents:
Secure software concepts; System issues; System properties; Software Project Time Management; Software Project Costing; Software Quality Assurance; Security Concepts in the SDLC; Risk management; Security standards (e.g., coding standards, NIST standards, Federal Information Processing Standards); Best practices (e.g., OWASP development guide, OWASP

CSC373 Secure Software Design and Development (3-0)
code review guide, OWASP testing guide); Security methodologies (e.g., Socratic Methodology, Operationally Critical Threat, Asset, and Vulnerability Evaluation, STRIDE and DREAD, Open Source Security Testing Methodology Manual); Security frameworks (e.g., Zachman Framework, Control Objectives for Information and Related Technology, Sherwood Applied Business Security Architecture (SABSA)); RegulationsPrivacy and Compliance; Security Models (e.g., BLP Confidentiality Model, Clark and Wilson Model (Access Triple Model)); Trusted Computing; Secure Software Requirements (Sources for Security Requirements, Types of Security Requirements); Secure Software Design (Design consideration, Information Technology Security Principles and Secure Design, Designing Secure Design Principles); Design Processes; Secure Software Implementation/Coding; Software Development Methodologies; Common Software Vulnerabilities and Controls; Defensive Coding Practices—Concepts and Techniques; Code Vulnerabilities and Avoiding Polymorphic Malware Attacks: Buffer overflow, Format string bug, Code vulnerabilities SQL Injection, Cross-site Scripting, Cross-site Request Forgery, Session management, Replication of vulnerabilities and exploitation; Secure Software Testing; Security Testing Methodologies; Software Security Testing; Software Acceptance; Legal Protection Mechanisms; Software Deployment-Operations- Maintenance and Disposal.
Text Book: 1. Official (ISC)2 Guide to the CSSLP (latest) 2. Software Security: Building Security In, 1st Edition by Gary McGraw

CSC374 Digital Forensics (3-0)
Contents: An introduction to Digital Forensics; use of digital forensics; Key technical concepts; Challenges in Digital Forensics ; The Difference between Computer Experts and Digital Forensics Experts; Investigative Process Methodologies ; Education, Training, and Awareness; Laws, Standards, and Regulations; Ethics and Professional Conduct; Digital Evidence Management; Collecting evidence; Anti Forensics; Network forensics; Mobile and Embedded Forensics; Cloud forensics; Internet Forensics; social media forensics; Investigation Methods for Collecting Digital Evidence; Digital Forensic Readiness; Digital forensics tools; Discovery of Computers and Storage Media; Discovery of Audio/ Video Evidence; Data Visualization; Data Sources; Graphing and Charting; Analyzing Data; Data Distributions; Analysis Scenarios; Data Visualization Tools.
Text Book: 1. The Basics of Digital Forensics: The Primer for Getting Started in Digital Forensics by John Sammons, 2nd Edition or latest 2. Digital Forensics and Incident Response : Incident Response Techniques and Procedures to Respond to Modern Cyber Threats, 2nd Edition 3. Guide to Digital Forensics : A Concise and Practical Introduction by Joakim Kävrestad (latest edition)

CSC470 Vulnerability Assessment and Reverse Engineering (3-0)

Contents:
Understanding the need for security assessments; Classifying vulnerabilities; Software vulnerabilities; Network vulnerabilities; Vulnerability assessment versus penetration testing; Vulnerability Assessment Tools; Vulnerability management Regulatory compliance; Calculating ROIs; Application review process; Pre-assessment; Code navigation; Code Auditing tactics; Memory corruption; understanding issues in programming languages; Steps in Reverse engineering, Common tools used for Reverse engineering; Binary Obfuscation techniques; Understanding core assembly concepts to perform malicious code analysis, Identifying key assembly logic structures with a disassembler, Malware analysis Types of malware analysis; Malware Taxonomy; Static analysis; Dynamic analysis; Malware Inspection; Malware analysis tools; Sandboxing and virtualization;

Text Book:
1. Finding and Fixing Vulnerabilities in Information Systems: The Vulnerability Assessment and Mitigation Methodology by Philip S. Anton
2. The Art of Software Security Assessment: Identifying and Preventing Software Vulnerabilities by Mark Dowd
3. Reversing: Secrets of Reverse Engineering by Eldad Eilam (latest edition)

CSC471 Malware Analysis and Development (3-0)

Contents:
Introduction to Malware Analysis, Malware Analysis Techniques, Advanced Static Analysis, Advanced Dynamic Analysis, Malware Reverse Engineering, Malware Code Analysis, Malware Persistence and Evasion Techniques, Malware Detection and Signature Development, Behavior-based Malware Detection, Malware Detection and Signature Development, Behavior-based Malware Detection, Cloud based malware analysis, IoT Malwares, IoT malware analysis. Code Injection and Hooking, Malware Obfuscation Techniques, Malware Development, Malware Communication protocols

Text Book:
1. Malware Analysis and Detection Engineering: A Comprehensive Approach to Detect and Analyzing Modern Malware 1st ed. Edition
2. Learning Malware Analysis by Monnappa K A

CSC472 Penetration Testing (3-0)

Contents:
Introduction to Penetration Testing, Kali Linux Introduction, Searching, Installing, and

CSC472 Penetration Testing (3-0)

Removing Tools, Piping and Redirection, Text Searching and Manipulation, Editing Files from the Command Line, Practical Tools(Netcat, Netcat, PowerShell and Powercat, Wireshark etc), Wireshark, Passive Information Gathering, Active Information Gathering, Web Application Attacks, Introduction to Buffer Overflows, Windows Buffer Overflows, Linux Buffer Overflows, Client-Side Attacks, Fixing Exploits, File Transfers, Antivirus Evasion, Bypassing Antivirus Detection, Privilege Escalation, Password Attacks, Port Redirection and Tunneling, Port Redirection and Tunneling, The Metasploit Framework, PowerShell Empire, Public Network Enumeration, Targeting the Web Application, Targeting the Database,

Text Book:
Penetration Testing with Kali Linux by Offensive Security

CSC473 Ethical Hacking (3-0)

Contents:
Legal Issues: Fourth Amendment, Computer Fraud and Abuse Act, Electronic Communications Privacy Act, Federal WireTap. Ethical Considerations: Consent, Exceeding scope and authority, Hack back, Snooping, Disruption of service, Intent versus authorization. Historical review of hacking. Footprinting and Reconnaissance: Open gathering, Passive gathering, Internet gathering, Social Engineering. Scanning: Types of scans, OS Fingerprinting, Proxies, Network Diagramming. Enumeration: Windows user and system gathering, Unix and Linux system gathering. System compromise: Hacking, Authentication, Covering your tracks, Malicious software and covert connections. Network traffic sniffing: Current tools, Switched network attacks. Social Engineering: Phases of an attack, Common targets, Common sources of information. Web Servers and applications: Common attacks and flaws, Current tools. Physical Security: Simple controls, Mobile access and concerns.

Text Book:
1. Hacking For Dummies, 5th Edition By Kevin Beaver (Copyright © 2000- 2018 by John Wiley & Sons, Inc., or related companies. All rights reserved.)
2. Hacking for dummies 4th edition By Kevin Beaver (Copyright © 2000-2018 by John Wiley & Sons, Inc., or related companies. All rights reserved

CSC474 Cryptography and Cryptanalysis (3-0)

Contents:
Introduction to network security, Symmetric encryption principles, Cryptography, Cryptanalysis techniques, feistel, cipher structure, Block Ciphers and Stream Ciphers Data Encryption Standard, Triple DES, Advanced Encryption Standard, Stream Ciphers, RC4 Encryption Standard, Cipher Block Modes of Operations, Location of Encryption Devices, Key Distribution, Public Key cryptography and message authentication, Approaches to message

CSC474 Cryptography and Cryptanalysis (3-0)
authentication, Hashing Secure, Hash functions and HMAC, SHA-1/ MD5, Overview of other secure hash Algorithms, Public key Encryption structure, Applications for public key cryptosystem, Requirements of PKC, Algorithms for PKC, RSA, Diffie-Hellman, brief introduction of other PKC Algorithms, DSS, ECC, Digital Signatures, Key Management, Cryptanalysis attacks Cryptanalysis of Shift cipher, substitution cipher, affine cipher, Monoalphabetic, ciphers, Polyalphabetic ciphers, Eyeball Methods, Frequency Analysis, Mathematical background, Cryptanalysis techniques and Tools
Text Book: 1. Cryptography and Network Security: Principles and Practice , Prentice Hall, by William Stallings, edition: 7th 2. Cryptography Theory and Practice, Author: Douglas R. Stinson edition: 4th 3. Applied Cryptography: Protocols, Algorithms, and Source Code in C Author: Bruce Schnier, Edition: 2nd 4. Handbook of Applied Cryptography (Discrete Mathematics and Its Applications)Author: Alfred J. Menezes, Edition: 1st

CSC380 Introduction to Data Science (3-0)
Contents: Introduction to Data Warehouse and Business Intelligence; Necessities and essentials of Business Intelligence; DW Life Cycle and Basic Architecture; DW Architecture in SQL Server; Logical Model; Indexes; Physical Model; Optimizations; OLAP Operations, Queries and Query Optimization; Building the DW; Data visualization and reporting based on Data Warehouse using SSAS and Tableau; Data visualization and reporting based on Cube; Reports and Dashboard management on PowerBI; Dashboard Enrichment; Business Intelligence Tools
Text Book: 1. W. H. Inmon, "Building the Data Warehouse", Wiley-India Edition. 2. Ralph Kimball, "The Data Warehouse Toolkit – Practical Techniques for Building Dimensional Data Warehouse," John Wiley & Sons, Inc. 3. Matteo Golfarelli, Stefano Rizzi, "Data Warehouse Design - Modern Principles and Methodologies", McGraw Hill Publisher

CSC381 Statistics for Data Science (3-0)
Contents: Introduction to Statistics and Data Science, Multivariate Random Variables, Descriptive Statistics, Bayesian Statistics, Hypothesis testing, Markov Chains, Probability Theory, Statistical Distributions, Statistical Inference, Parametric Tests, Non-Parametric Tests, Regression Analysis, Math for Machine Learning, Math for Deep Learning, CNN, NLP,

CSC381 Statistics for Data Science (3-0)
Dimensional Reduction, Ensemble Learning and Model Evaluation, Tools for Data Science.
Text Book: 1. Probability and Statistics for Data Science by Carlos Fernandez-Granda, 2. Practical Statistics for Data Scientists Peter Bruce, Andrew Bruce & Peter Gedeck

CSC382 Data Mining (3-0)
Contents: Introduction to data mining and basic concepts, Pre-Processing Techniques & Summary Statistics, Association Rule mining using Apriori Algorithm and Frequent Pattern Trees, Introduction to Classification Types, Supervised Classification (Decision trees, Naïve Bae Classification, K-Nearest Neighbors, Support Vector Machines etc.), Unsupervised Classification (K Means, K Median, Hieratical and Divisive Clustering, Kohonan Self Organizing maps), outlier & anomaly detection, Web and Social Network Mining, Data Mining Trends and Research Frontiers. Implementing concepts using Python
Text Book: 1. Jiawei Han & Micheline Kamber, Jian Pei (2011). Data Mining: Concepts and Techniques, 3rd Edition. 2. Pang-Ning Tan, Michael Steinbach, and Vipin Kumar (2005). Introduction to Data Mining. Charu C. Aggarwal (2015). Data Mining: The Textbook 3. D. Hand, H. Mannila, P. Smyth (2001). Principles of Data Mining. MIT Press.

CSC383 Data Visualization (3-0)
Contents: Introduction of Exploratory Data Analysis and Visualization, Building Blocks and Basic Operations; Types of Exploratory Graphs, single and multi-dimensional summaries, five number summary, box plots, histogram, bar plot and others; Distributions, their representation using histograms, outliers, variance; Probability Mass Functions and their visualization; Cumulative distribution functions, percentile-based statistics, random numbers; Modelling distributions, exponential, normal, lognormal, pareto; Probability density functions, kernel density estimation; Relationship between variables, scatter plots, correlation, covariance; Estimation and Hypothesis Testing; Clustering using K-means and Hierarchical; Time series and survival analysis; Implementing concepts with R (or similar language)
Text Book: 1. "Exploratory Data Analysis with R" by Roger D. Peng

CSC384 Data Warehousing and Business Intelligence (3-0)

Contents:
Introductions / Welcome, Getting around Canvas, SQL, Introduction to Data Warehousing, Data Warehouse Constructs and Components, Project Management & Requirements Gathering, Introduction to Dimensional Modeling, Dimensional Modeling Design, Technical Architecture, Technical Architecture, Introduction to ETL design, ETL Development, Master Data Management & Data Governance, Introduction to Business Intelligence, Business intelligence design and development

1. W.H. Inmon, Claudia Imhoff, Ryan Sousa. Corporate Information Factory. Wiley. ISBN: 0471399612 Edition: 2nd , Year: 2002, Publisher: Wiley
2. Ralph Kimball, Margy Ross, Warren Thornthwaite, Joy Mundy, Bob Becker. The Data Warehouse Lifecycle Toolkit: Practical Techniques for Building Data Warehouse and Business Intelligence Systems. Wiley. ISBN: 9780470149775Text Book:

CSC480 Big Data Analytics (3-0)

Contents:
Introduction Hadoop and Map Reduce, Association Rules: Frequent item sets and association rule mining, Similar item sets and LSH, Near Neighbor Search in High Dimensional Data, Recommender systems, Link analysis: Personalized PageRank, Hubs and Authorities, Web spam and Trust Rank, Clustering, Descriptive analytics, clustering, Dimensionality reduction: SVD a, Machine learning with massive datasets, Mining streaming data, Analysis of very large graphs, Time series data and streaming, Other application areas, Proximity search on Graphs: Random Walks with Restarts, Web Advertising

Text Book:
1. Mining of Massive Datasets, 1st Edition, Anand Rajaraman and Jeffrey Ullman

CSC481 Cloud Computing (3-0)

Contents:
Introduction, Cloud computing definition, characteristics of cloud computing, Advantages of cloud computing, cloud computing service models, Infrastructure as a service, Platform as a service, Software as a service, Introduction to cloud deployment models, public cloud, private cloud, hybrid cloud, community cloud, cloud-based services and applications, case study: cloud computing in Business, cloud charging models, service level agreements, monitoring services, Introduction to distributed computing, cluster computing, grid computing, client server model, p2p systems, introduction to virtualization, server consolidation, full virtualization, Para virtualization, hardware assisted virtualization, Create Your First Virtual Machine, Install Linux Operating System in Virtual Machine, Introduction to Linux, Linux: Installing Software, Linux:

CSC481 Cloud Computing (3-0)
System Log Files, Linux: Directory Structure, Linux: Basic Commands Part 1, Linux: Basic Commands Part 2, Linux: Basic Commands Part 3, Cloud security challenges, Reliability and Availability, Interoperability and Portability, Application Scalability in Cloud, Scale-out and Scale- up, Replication in Cloud, Web Application Scaling through Replication, Introduction to Inter- process Communication (IPC), Sockets, Building a Simple Distributed Application using Sockets, Pipes, Pipes Example in Linux, Remote Procedural Call (RPC), RPC examples using Java RMI, Introduction to Zookeeper, Introduction to Clock Synchronization, Clock Drift and Skew, Cristian's Algorithm, Simple Network Time Protocol (SNTP), Berkley's Algorithm, Introduction to Fault Tolerance, Characteristics of a Dependable System, Failure Modes
Text Book: 1. Cloud Computing: Concepts, Technology & Architecture, 1st edition. Ricardo Puttini, Thomas Erl, and Zaigham Mahmood. Prentice Hall, 2013 2. Cloud Computing 1ST edition. Kris Jamsa. Jones & Bartlett Learning, 2013

CSC482 Internet of Things (3-0)
Contents: Introduction – Concepts behind the Internet of Things. The IoT paradigm, Smart objects, Bits and atoms, Goal orientation, Convergence of technologies, Technologies behind the Internet of Things. RFID + NFC, Wireless networks + WSN, RTLS + GPS, Agents + Multiagent systems, Creative thinking techniques, Modifications, Combination scenarios, Breaking assumptions, Solving problems, Internet of things in retail. A presentation by Ramir De Porrata-Doria, CEO of Keonn, Technologies.37, NFC applications for the IoT. Presentation by Pedro Martínez, CEO at NXP m-Knowledge Center. Livinglab co creation for the IoT. Presentation by Heiner Lehr, Partner at Syntesa.
Text Book: 1. The Second Machine Age: Work, Progress and Prosperity in a Time of Brilliant Technologies by Erik Brynjolfsson and Andrew McAfee. Edition: 1st, Year: 2016, Publisher: W. W. Norton & Company 2. The Silent Intelligence by Daniel Kellmereit and Daniel Obodovski. Edition: 1st , Year:2013, Publisher: DND Ventures LLC

CSC483 Business Process Analysis (3-0)
Contents: Business process management, Manufacturing and services processes, Modelling and charting tools, Lean processes Improvement workshop techniques, Business process outsourcing, Re-engineering and improvement cases

CSC483 Business Process Analysis (3-0)

Text Book:
1. Business Process Improvement; The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness, H. J. Harrington
2. Business Intelligence: A Managerial Approach by Turban, Sharda, Delen, King, 2nd Edition, Prentice Hall (2011). ISBN: 13-978-0-136-10066-9

CSC484 Platforms and Architectures for Data Science (3-0)

Contents:
The Data Messaging System (ETL): Apache Kafka, Amazon Kinesis, TIBCO Spotfire, and RabbitMQ; Data Storage: Velocity, Volume, Variety, Latency Feature Store implementations such as Feast, Tecton, or Hopsworks or development of your own using spark; Data Version Control (DVC) and ML Flow; Production Platforms and Dashboards; Monitoring Tools for Performance of Data Models; Meta Data Store; Data Science Virtual Machine; Azure HDInsight Spark clusters; Azure Synapse Analytics; Azure Data Lake; Azure HDInsight Hive (Hadoop) clusters.

Text Book:
1. Data Science on the Google Cloud Platform books Valliappa Lakshmanan · 2022
2. IBM Cloud Pak for Data Hemanth Manda, Sriram Srinivasan, Deepak Rangarao · 2021

CSC485 Text Mining (3-0)

Contents:
Introduction to Text Mining, Natural language processing (NLP) basic techniques: tokenization, part-of-speech tagging, chunking, syntax, parsing and named entity recognition, Public NLP toolkits. Document representation: how to represent unstructured text documents with appropriate format and structure for automated text mining algorithms. Text categorization: basic supervised text categorization algorithms: Naive Bayes, k Nearest Neighbor (kNN) and Logistic Regression, Support Vector Machines and Decision Trees.Introduction to Neural Networks (NN) for NLP. Text clustering: clustering algorithms, i.e., connectivity-based clustering (hierarchical clustering) and centroid-based clustering (e.g., k-means clustering).Topic modeling: basic topic models, i.e., Probabilistic Latent Semantic Indexing (pLSI) and Latent Dirichlet Allocation (LDA) for classification, annotation, collaborative filtering, and hierarchical topical structure modeling. Document summarization: Extraction based summarization methods: Sentiment analysis: problems in sentiment analysis, including sentiment polarity prediction, review mining, and aspect identification, sequence to sequence models, Machine Translation, Dialogue Systems, Text visualization: mathematical and programming tools to visualize a large collection of text documents

Text Book:

CSC485 Text Mining (3-0)
1. Mining Text Data. Charu C. Aggarwal and ChengXiang Zhai, Springer, 2012. 2. Text Mining HandBook: Advanced approaches in analyzing unstructured Data, Cambridge University Press

CSC486 Topics in Data Science (3-0)
Contents: Overview of Data Science Process, Data objects and attribute types, Descriptive Statistics: Measures of Central Tendency, Measures of Data Dispersion: Range, Quartiles, Variance, Standard Deviation, and Interquartile Range, Outliers, Data Sampling Methods, Sources of Bias, Data Cleaning, Exploratory Data Analysis, Data Visualization and Transformations, Correlation Analysis, Designing Experiment, Observation based Studies, Causal Relations, Associations, Statistical Inference, Hypothesis Testing and p-values, A/B testing, Bootstrap Sampling, Confidence Intervals. Introduction to Machine Learning Models, Regression and Linear Models, Gradient Descent, Feature Engineering and Bias-variance tradeoff, Cross-validation and Regularization, Introduction to classification: Decision Trees and Random Forests, Data Ethics
Text Book: 1. Doing Data Science, Cathy O'Neil, Rachel Schutt, O'Reilly Media, Inc 2. Principles and Techniques of Data Science, Sam Lau, Joey Gonzalez, Deb Nolan, UC Berkley

CSC390 Mobile Multimedia (3-0)
Contents: Introduction to Mobile Game Development, Introduction to tools use for mobile game development, Introduction to Multimedia Concepts, Graphics and Animation for Mobile games, Audio Design for Mobile Games, User Interface Design for Mobile Games, Mobile Game Performance Optimization, Mobile Game Publishing and Monetization
Text Book: 1. Unity Game Development Cookbook Essentials for Every Game by Paris Buttfield-Addison, Jon Manning, Tim Nugent 2. Mobile Design and Development: Practical concepts and techniques for creating mobile sites and web apps 1st Edition by Brian Fling

CSC391 Game Development (3-0)
Contents: Math and Physics Review for 3D Games. Editing Scenes and Game Objects; Landscape Builder and Creating Shapes; Importing and Integrating Assets; Scripting Languages; Implementing Movement and Spawning; Developing Collisions and Health System; Head Up Displays; Materials, Effects, URP and Shaders; Developing Particle System; Adding Lighting; Full-Screen Effects Post Processing; Game Optimization;
Text Book: 1. Hands-On Unity 2022 Game Development by Nicolas Alejandro Borromeo 2. 3D Math Primer for Graphics and Game Development 2nd Edition by Fletcher Dunn (Author), Ian Parberry (Author)

CSC392 Interactive Games and Audio (3-0)
Contents: Introduction to Interactive Game Development, Audio Fundamentals for Games, Working with SFX Libraries, Recording Custom SFX, Unity & Real-World Sound Design for Games, Interactive Audio Systems, Game Audio Integration, Real-Time Audio Processing, Middleware for Game Audio, Interactive Game Sound Design, Demo Reels and Working in the Industry
Text Book: 1. The Game Audio Strategy Guide: A Practical Course by Gina Zdanowicz and Spencer Bambrick, Focal Press 2. Principles of Game Audio and Sound Design: Sound Design and Audio 3. Implementation for Interactive and Immersive media by Jean-Luc Sinclair, Focal Press 4. Game Audio Development with Unity 5.x by Michael Lanham, Packt

CSC393 Game Programming (3-0)
Contents: Introduction to Game Development, Introduction to game programming technologies, Programming Game Mathematics and Physics, Game AI (Artificial Intelligence), Game Scripting and Gameplay Mechanics, Game Graphics and Rendering, Optimization of Game Graphics with programming, Design patterns for game development, Game Audio and Sound Design, Game Testing and Debugging
Text Book: 1. Introduction to Game Development 2nd Edition by Steve Rabin 2. Game Programming Patterns by Robert Nystrom

CSC394 Video Production Techniques (3-0)

Contents:
Introduction to Video Production for games, 2D Character Designing, 3D Character Designing, Tools for Animation Development, Animation Development, Storytelling and Scriptwriting for Game Videos, Pre Production Planning, Cinematography and Camera Techniques, Lighting and Set Design for Game Videos, Audio Recording and Editing Videos,
Game Intro Designing, Motion Graphics and Visual Effects, Video Compression and Distribution

Text Book:
1. Game Design Theory & Practices 2nd Edition by Richard Rouse
2. People, Planning and Production for Video Game Development: Supplemental Game Production Guide by Gerard C. Merritt

CSC490 Game Play and Game Mechanics (3-0)

Contents:
Writing a compelling story; Defining the Spine; Three-Act Structure and Rising Action; Characters and Character Goals, Using Secondary Characters, Writing a Character Brief; Game Design Document; Gameplay Flowchart; Designing Game Mechanics; Emergence and Progression; Complex Systems and the Structure of Emergence; Internal Economy; Machinations; Common Mechanisms; Design Patterns; Simulating and Balancing Games; Building Economies; Integrating Level Design and Mechanics; Progression Mechanisms; Meaningful Mechanics

Text Book:
1. Game Mechanics: Advanced Game Design (Voices That Matter) by Ernest Adams (Author), Joris Dormans (Author)
2. The Art of Game Design: A Book of Lenses By Jesse Schell · 2008

CSC491 3D Game Development (3-0)

Contents:
Math and Physics Review for 3D Games. Editing Scenes and Game Objects; Landscape Builder and Creating Shapes; Importing and Integrating Assets; Scripting Languages; Implementing Movement and Spawning; Developing Collisions and Health System; Head Up Displays; Materials, Effects, URP and Shaders; Developing Particle System; Adding Lighting; Full Screen Effects Post Processing; Game Optimization;

Text Book:
1. Hands-On Unity 2022 Game Development by Nicolas Alejandro Borromeo

CSC491 3D Game Development (3-0)
2. 3D Math Primer for Graphics and Game Development 2nd Edition by Fletcher Dunn (Author), Ian Parberry

CSC492 Programming Game AI (3-0)
Contents: Use of AI in Games and its importance; Autonomous and Intelligent Agents; state- and goal-based behavior, inter-agent communication, individual and group steering behaviors, team AI, graph theory, search, path planning and optimization, triggers, scripting, scripted finite state machines, perceptual modeling, goal evaluation, goal arbitration, and fuzzy logic; Games and Reinforcement Learning; Development of Intelligent Enemies; Adaptive Games.
Text Book: 1. AI for Games, Third Edition 3rd Edition by Ian Millington

CSC493 Game Marketing (3-0)
Contents: The Market for video games; Marketing Strategy and Marketing Mix; Video Games as product or services; Brands and Video Games; Marketing Communication and Video Games; marketing Research for Game Development; Postmodern marketing; Marketing as practicing; future of game development; Advergames and in-game advertising; Gamification and Alternate Reality
Text Book: 1. Games; Game Website and SEO; Video Game Marketing: A student textbook Front Cover Peter Zackariasson, Mikolaj Dymek