COMPUTER SCIENCE & ENGINEERING

UG CURRICULUM (2020-21 SESSION ONWARDS)

A. COURSES / CREDITS DISTRIBUTION

I. Institute Core Courses (ICC) – 37 Credits
   a. Basic Science Courses (BSC) – 16 Credits
   b. Engineering Science Courses (ESC) – 17 Credits
   c. General Science Courses (GSC) – 4 Credits

II. Humanities, Communication and Management Elective Courses (HSSMEC) – 12 Credits

III. Departmental Core Courses (DCC) – 39 Credits
(including 3 credits of Minor Project)

IV. Departmental Elective Courses (DEC) – 20 Credits

V. Institute Open Elective Courses – 30 Credits
   a. Open Elective Courses – 24 Credits
   b. Project (Compulsory Major Project) – Interdisciplinary – 6 Credits

VI. Internship (Optional) / Course Work – 12 Credits
(Students Opting for course work will do department elective (4 credits), open elective (4 credits) and Project Work (4 Credits)

VII. Non-Academic Courses (NAC) – 10 Credits

Total Credits (without Honours): 160
Honours: 16 Credits
Total Credits (with Honours): 160 + 16 = 176

- **Major Specialization:**
  Major Specialization will be given to a student who earns 16 credits (within 160 credits) in any one domain of Department Elective Courses (DEC) offered by the CSE department.

- **Minor Specialization:**
  Minor Specialization in CSE will be given to a student of outside the CSE department who earns 16 credits (within 160 credits) from the basket of Open Elective Courses offered by the CSE department as Minor Specialization Courses (MSC).

- **Honours:**
  To get Honours in CSE, the student will have to complete additional 16 credits (over and above 160 credits) of Department Elective Courses (DEC) of CSE department offered as Department Honours Courses (DHC).

B. SPECIALIZATION DOMAINS

I. Artificial Intelligence & Machine Learning (AI & ML)

1. Machine Learning – DEC- I
2. Logic and Functional Programming – DEC-I
3. Concepts in Statistical Learning Theory – DEC-II
4. Natural Language Processing – DEC-II
5. Pattern Recognition – DEC-III
6. Deep Leaning – DEC- III
7. Advances of Intelligent and Learning Agents – DEC-IV
8. Advanced Artificial Intelligence – DEC- IV
9. Computational Genomics – DEC- V
10. Computer Vision –DEC-V
11. Bioinformatics – DEC- V
12. Computational Cognitive Science – (DHC-4)
13. Knowledge Representation and Reasoning – DE (6^{th} Sem)

II. Network Systems & Security (NSS)

1. Introduction to Internet of Things – DEC- I
2. Wireless & Mobile Networks – DEC-I
3. Applied Cryptography – DEC-II
4. High Speed Networks – DEC-II
5. Network Administration and Management – DEC-III
6. Mobile and Wireless Network Security – DEC-III
7. Wireless Sensor Networks – DEC-IV
8. Mobile Computing – DEC-IV
9. Advanced IOT with SDN (Industry 4.0) – DEC-V
10. Computer Crime Investigation and Forensics – DEC-V
11. Special Topics in Wireless and Mobile Networks – (DHC-3)
12. Advanced Computer Networks – DE (6^{th} Sem)

III. Computing & Information Systems (CIS)

1. Introduction to Information Science– DEC-I
2. Microprocessor and its Applications – DEC-I
3. Web Information Retrieval and Crawling – DEC-II
4. Clean Coding Practices – DEC-II
5. Distributed Algorithm Design – DEC-III
6. Agile Software Development and Modern Practices – DEC-III
7. Digital Image Processing – DEC-IV
8. Cloud Computing – DEC-IV
9. Advanced Computer Architecture – DEC-V
10. Recommender System – DEC-V
11. Advanced Algorithm Design and Analysis – DEC-V
12. Database Systems – (DHC-1)
13. Compiler Design – (DHC-2)

C. TEACHING SCHEME

First Year

Semester I

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	OR1101	Orientation Course (2 Credits) (including Introduction to Discipline Engg -1 credit 14 hours) (i) Orientation (ii) Introduction to Computer Science and Engineering	 1	 0	 0	 1 1	NAC
2.	MA1101	Calculus and Ordinary Differential Equations	3	1	0	4	BSC-I
3.	CH1101	Applied Chemistry-I	3	0	2	4	BSC-IV
4.	ES1101	Introduction to Computing*	3	0	2	4	ESC-I
5.	ES1201	Engineering Drawing with CAD Software	2	0	2	3	ESC-II
6.	ES1301	Introduction to Mechatronics	2	0	2	3	ESC-III
					Total Credits	20	

*Common to all branches

Semester II

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	PY1201	Electromagnetic Theory and Quantum Physics	3	0	2	4	BSC-II
2.	MA1301	Probability and Statistics	3	1	0	4	BSC-III
3.	ES1401	Introduction to Electronics & Electrical Engineering	2	0	0	2	ESC-IV
4.	ES1501	Introduction to Manufacturing	2	0	0	2	ESC-V
5.	GS1101 & GS1201	Introduction to Environmental Sciences – I Introduction to Environmental Sciences - II	2 1	0 0	0 2	2 2	GSC-I & GSC-II
6.	HS1101	Communication Skills & Ethics	2	0	2	3	HSM-I
					Total Credits	19	

Second Year

Semester III

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	ES1701	Artificial Intelligence and Machine Learning*	2	0	2	3	ESC-VII
2.	CS1301	Data Structures	3	0	2	4	DCC-I
3.	CS1302	Computer Architecture & Organization	3	0	2	4	DCC-II
4.	CS1303	Discrete Structures for Computer Science	3	1	0	4	DCC-III
5.	CS6301/CS5301	#Open Elective – I (OE-I) / Minor Specialization Course (MSC)	3	0	2	4	OE-I/MSC
6.	CS7301	Industrial Tour				2	NAC
					Total Credits	21	

*Common to All branches

#Open Elective course will not be offered to B.Tech. (CSE) students

Open Elective – I (OE-I) / Minor Specialization Course (MSC)#

Sr. No.	Course Code OE-I/MSC	Course Name	L	T	P	Credits	Category
1.	CS6301/ CS5301	Data Structures#	3	0	2	4	OE-I/MSC

#Open Elective course (Data Structures) will not be offered to B.Tech. (CSE) students

Semester IV

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	HS2301 / HS2302 / HS2303 / HS2304	Basics of Economics / French- Basic / General Psychology / Sociology	2 2 2 2	1 1 1 1	0 0 0 0	3	HSM-II
2.	CS1401	Analysis & Design of Algorithms	3	0	2	4	DCC-IV
3.	CS1402	Operating Systems	3	0	2	4	DCC-V
4.	CS1403	Computer Networks	3	0	2	4	DCC-VI
5.	CS6401/ CS5401	*Open Elective –II (OE-II) / Minor Specialization Course (MSC)	3	0	2	4	OE-II/MSC
6.	PC7401	Proficiency-I				2	Proficiency
					Total Credits	21	
Department Honours Course – 1 (DHC-1)							
7.	CS3401	Database Systems	3	0	2	4	DHC-I
					Total Credits (Including Honours)	25	

*Open Elective course will not be offered to B.Tech. (CSE) students

Open Elective – II (OE-II) / Minor Specialization Course (MSC)*

Sr. No.	Course Code OE-II/MSC	Course Name	L	T	P	Credits	Category
1.	CS6401/ CS5401	Analysis and Design of Algorithms*	3	0	2	4	OE-II/MSC

*Open Elective course (Analysis and Design of Algorithms) will not be offered to B.Tech. (CSE) students

Third Year

Semester V

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS1501	Theory of Computation	3	1	0	4	DCC-VII
2.	CS1502	Soft Computing	3	0	2	4	DCC-VIII
3.	CS1503	Software Engineering	3	0	2	4	DCC-IX
4.	CS1504	Minor Project	0	0	6	3	DCC-X
5.	CS2501 to CS2506	Department Elective Course – I (DEC-I)	3	0	2	4	DEC-I
6.	CS2507 to CS2512	Department Elective Course – II (DEC-II)	3	0	2	4	DEC-II
					Total Credits	23	
Department Honours Course – 2 (DHC-2)							
7.	CS3501	Compiler Design	3	0	2	4	DHC-2
					Total Credits (Including Honours)	27	

Department Elective Course - I (DEC-I)

Sr. No.	Course Code DEC-I/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2501/CS4501	Machine Learning	3	0	2	4	AI& ML
2.	CS2502	Logic and Functional Programming	3	0	2	4	AI& ML
3.	CS2503	Introduction to Internet of Things	3	0	2	4	NSS
4.	CS2504/CS4502	Wireless & Mobile Networks	3	0	2	4	NSS
5.	CS2505/CS4503	Introduction to Information Science	3	0	2	4	CIS
6.	CS2506	Microprocessor and its Applications	3	0	2	4	CIS

Department Elective Course - II (DEC-II)

Sr. No.	Course Code	Course Name	L	T	P	Credits	Specialization domain
1.	CS2507	Concepts in Statistical Learning Theory	3	0	2	4	AI& ML
2.	CS2508	Natural Language Processing	3	0	2	4	AI& ML
3.	CS2509	Applied Cryptography	3	0	2	4	NSS
4.	CS2510	High Speed Networks	3	0	2	4	NSS
5.	CS2511	Web Information Retrieval and Crawling	3	0	2	4	CIS
6.	CS2512	Clean Coding Practices	3	0	2	4	CIS

Semester VI

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS8601	Internship Training (Optional)	0	0	24	12	Internship
(OR)							
Students Opting for course work will do department elective (4 credits), open elective (4 credits) and Project Work							
1.	CS2601 to CS2602	Department Elective	3	0	2	4	DE
2.	CS6601 to CS6602	Open Elective*	3	0	2	4	OE
3.	CS7601	Project Work	0	0	8	4	Project
Total Credits						12	

*Open Elective course will not be offered to B.Tech. (CSE) students

Department Elective

Sr. No.	Course Code	Course Name	L	T	P	Credits	Specialization domain
1.	CS2601	Knowledge Representation and Reasoning	3	0	2	4	AI& ML
2.	CS2602	Advanced Computer Networks	3	0	2	4	NSS

Open Elective*

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS6601	Data and Communication Networks*	3	0	2	4	OE
2.	CS6602	IT Concepts in Engineering*	3	0	2	4	OE

*Open Elective course will not be offered to B.Tech. (CSE) students

Final Year

Semester VII

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	HS2701 / HS2702 / HS2703 / HS2704 / HS2705 / HS2706 / HS2707 / HS2708	Anthropology / Appreciation of Art / English Literature / History / Introduction to Art History / Philosophy- an Introduction / Political Science / Public Administration	2 3 2 3 3 3 2 2	1 0 1 0 0 0 1 1	0 0 0 0 0 0 0 0	3	HSM-III
2.	CS2701 to CS2706	Department Elective Course – III (DEC-III)	3	0	2	4	DEC-III
3.	CS2707 to CS2712	Department Elective Course – IV (DEC-IV)	3	0	2	4	DEC-IV
4.	CS6701/ CS5701	*Open Elective –III/ Minor Specialization Course (MSC)	3	0	2	4	OE-III/MSC
5.	CS6702	*Open Elective –IV	3	0	2	4	OE-IV
6.	CS7701	Major Project-I	0	0	4	2	Project
					Total Credits	21	
Department Honours Course – 3 (DHC-3)							
7.	CS3701	Special Topics in Wireless and Mobile Networks	3	0	2	4	DHC-3
					Total Credits (Including Honours)	25	

* Open Elective course will not be offered to B.Tech. (CSE) students

Department Elective Course - III (DEC-III)

Sr. No.	Course Code DEC-III/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2701	Pattern Recognition	3	0	2	4	AI& ML
2.	CS2702/CS4701	Deep Learning	3	0	2	4	AI& ML
3.	CS2703	Network Administration and Management	3	0	2	4	NSS
4.	CS2704/CS4702	Mobile and Wireless Network Security	3	0	2	4	NSS
5.	CS2705/CS4703	Distributed Algorithm Design	3	0	2	4	CIS

6.	CS2706	Agile Software Development and Modern Practices	3	0	2	4	CIS

Department Elective Course - IV (DEC-IV)

Sr. No.	Course Code DEC-IV/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2707	Advances of Intelligent and Learning Agents	3	0	2	4	AI& ML
2.	CS2708/CS4704	Advanced Artificial Intelligence	3	0	2	4	AI& ML
3.	CS2709/CS4705	Wireless Sensor Networks	3	0	2	4	NSS
4.	CS2710	Mobile Computing	3	0	2	4	NSS
5.	CS2711	Digital Image Processing	3	0	2	4	CIS
6.	CS2712/CS4706	Cloud Computing	3	0	2	4	CIS

Open Elective – III (OE-III) / Minor Specialization Course (MSC)*

Sr. No.	Course Code OE-III/MSC	Course Name	L	T	P	Credits	Category
1.	CS6701/ CS5701	Computer Networks*	3	0	2	4	OE-III/MSC

*Open Elective course (Computer Networks) will not be offered to B.Tech. (CSE) students

Open Elective – IV (OE-IV)*

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS6702	Computer Architecture & Organization*	3	0	2	4	OE-IV

*Open Elective course (Computer Architecture & Organization) will not be offered to B.Tech. (CSE) students

Semester VIII

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	HS2801 /	Business Environment and Business Laws /	2	1	0	3	HSM-IV
	HS2802 /	Entrepreneurship and Project Management /	2	1	0		
	HS2803	Financial Management	2	1	0		
2.	CS2801 to CS2808	Department Elective Course – V (DEC-V)	3	0	2	4	DEC-V

3.	CS6801/ CS5801	*Open Elective –V/ Minor Specialization Course (MSC)	3	0	2	4	OE-V/MSC
4.	CS6802	*Open Elective –VI	3	0	2	4	OE-VI
5.	CS8801	Discipline				2	Discipline
6.	PC7801	Proficiency-II				2	Proficiency
7.	CS7801	Major Project-II	0	0	8	4	Project
					Total Credits	23	
Department Honours Course – 4 (DHC-4)							
8.	CS3801	Computational Cognitive Science	3	0	2	4	DHC-4
					Total Credits (Including Honours)	27	

* Open Elective course will not be offered to B.Tech. (CSE) students

Department Elective Course - V (DEC-V)

Sr. No.	Course Code DEC-V/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2801	Computational Genomics	3	0	2	4	AI& ML
2.	CS2802/CS4801	Computer Vision	3	0	2	4	AI & ML
3.	CS2803	Bioinformatics	3	0	2	4	AI&ML
4.	CS2804/CS4802	Advanced IOT with SDN (Industry 4.0)	3	0	2	4	NSS
5.	CS2805	Computer Crime Investigation and Forensics	3	0	2	4	NSS
6.	CS2806	Advanced Computer Architecture	3	0	2	4	CIS
7.	CS2807/CS4803	Recommender System	3	0	2	4	CIS
8.	CS2808	Advanced Algorithm Design and Analysis	3	0	2	4	CIS

Open Elective – V (OE-V) / Minor Specialization Course (MSC)*

Sr. No.	Course Code OE/MSC	Course Name	L	T	P	Credits	Category
1.	CS6801/ CS5801	Operating Systems*	3	0	2	4	OE-V/MSC

*Open Elective course (Operating Systems) will not be offered to B.Tech. (CSE) students

Open Elective – VI (OE-VI)*

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS6802	Software Engineering*	3	0	2	4	OE-VI

*Open Elective course (Software Engineering) will not be offered to B.Tech. (CSE) students

D. LIST OF COURSES

I. List of Institute Core Courses (ICC) – 37 credits

a. Basic Science Courses (BSC) – 16 Credits
b. Engineering Science Courses (ESC) – 17 Credits
c. General Science Courses (GSC) – 4 Credits

a. Basic Science Courses (BSC) – 16 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							
1.	MA1101	Calculus and Ordinary Differential Equations	3	1	0	4	BSC-I
2.	CH1101	Applied Chemistry-I	3	0	2	4	BSC-IV
Semester II							
3.	PY1201	Electromagnetic Theory and Quantum Physics	3	0	2	4	BSC-II
4.	MA1301	Probability and Statistics	3	1	0	4	BSC-III
					Total Credits	16	

b. Engineering Science Courses (ESC) – 17 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							
1.	ES1101	Introduction to Computing*	3	0	2	4	ESC-I
2.	ES1201	Engineering Drawing with CAD Software	2	0	2	3	ESC-II
3.	ES1301	Introduction to Mechatronics	2	0	2	3	ESC-III
Semester II							
4.	ES1401	Introduction to Electronics & Electrical Engineering	2	0	0	2	ESC-IV
5.	ES1501	Introduction to Manufacturing	2	0	0	2	ESC-V
Semester III							
6.	ES1701	Artificial Intelligence and Machine Learning*	2	0	2	3	ESC-VII
					Total Credits	17	

*Common to All Branches

c. General Science Courses (GSC) – 4 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester II							
1.	GS1101 & GS1201	Introduction to Environmental Sciences – I Introduction to Environmental Sciences - II	2 1	0 0	0 2	2 2	GSC I & GSC II
					Total Credits	4	

II. List of HSM Courses – 12 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester II							
1.	HS1101	Communication Skills & Ethics	2	0	2	3	HSM-I
Semester IV							
2.	HS2301 / HS2302 / HS2303 / HS2304	Basics of Economics / French- Basic / General Psychology / Sociology	2 2 2 2	1 1 1 1	0 0 0 0	3	HSM-II
Semester VII							
3.	HS2701 / HS2702 / HS2703 / HS2704 / HS2705 / HS2706 / HS2707 / HS2708	Anthropology / Appreciation of Art / English Literature / History / Introduction to Art History / Philosophy- an Introduction / Political Science / Public Administration	2 3 2 3 3 3 2 2	1 0 1 0 0 0 1 1	0 0 0 0 0 0 0 0	3	HSM-III
Semester VIII							
4.	HS2801 / HS2802 / HS2803	Business Environment and Business Laws / Entrepreneurship and Project Management / Financial Management	2 2 2	1 1 1	0 0 0	3	HSM-IV
					Total Credits	12	

III. List of Departmental Core Courses (DCC) – 39 credits

(including 3 credits of Minor Project)

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester III							
1.	CS1301	Data Structures	3	0	2	4	DCC-I
2.	CS1302	Computer Architecture & Organization	3	0	2	4	DCC-II
3.	CS1303	Discrete Structures for Computer Science	3	1	0	4	DCC-III
Semester IV							
4.	CS1401	Analysis and Design of Algorithms	3	0	2	4	DCC-IV
5.	CS1402	Operating Systems	3	0	2	4	DCC-V
6.	CS1403	Computer Networks	3	0	2	4	DCC-VI
Semester V							
7.	CS1501	Theory of Computation	3	1	0	4	DCC-VII
8.	CS1502	Soft Computing	3	0	2	4	DCC-VIII

9.	CS1503	Software Engineering	3	0	2	4	DCC-IX
10.	CS1504	Minor Project	0	0	6	3	DCC-X
					Total Credits	39	

IV. List of Department Elective Courses (DEC) – 20 credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester V							
1.	CS2501 to CS2506	Department Elective Course – I (DEC-I)	3	0	2	4	DEC-I
2.	CS2507 to CS2512	Department Elective Course – II (DEC-II)	3	0	2	4	DEC-II
Semester VII							
3.	CS2701 to CS2706	Department Elective Course – III (DEC-III)	3	0	2	4	DEC-III
4.	CS2707 to CS2712	Department Elective Course – IV (DEC-IV)	3	0	2	4	DEC-IV
Semester VIII							
5.	CS2801 to CS2808	Department Elective Course – V (DEC-V)	3	0	2	4	DEC-V
					Total Credits	20	

Department Elective Course - I (DEC-I)

Sr. No.	Course Code DEC-I/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2501/CS4501	Machine Learning	3	0	2	4	AI& ML
2.	CS2502	Logic and Functional Programming	3	0	2	4	AI& ML
3.	CS2503	Introduction to Internet of Things	3	0	2	4	NSS
4.	CS2504/CS4502	Wireless & Mobile Networks	3	0	2	4	NSS
5.	CS2505/CS4503	Introduction to Information Science	3	0	2	4	CIS
6.	CS2506	Microprocessor and its Applications	3	0	2	4	CIS

Department Elective Course - II (DEC-II)

Sr. No.	Course Code	Course Name	L	T	P	Credits	Specialization domain
1.	CS2507	Concepts in Statistical Learning Theory	3	0	2	4	AI& ML
2.	CS2508	Natural Language Processing	3	0	2	4	AI& ML
3.	CS2509	Applied Cryptography	3	0	2	4	NSS
4.	CS2510	High Speed Networks	3	0	2	4	NSS

5.	CS2511	Web Information Retrieval and Crawling	3	0	2	4	CIS
6.	CS2512	Clean Coding Practices	3	0	2	4	CIS

Department Elective Course - III (DEC-III)

Sr. No.	Course Code DEC-III/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2701	Pattern Recognition	3	0	2	4	AI& ML
2.	CS2702/CS4701	Deep Learning	3	0	2	4	AI& ML
3.	CS2703	Network Administration and Management	3	0	2	4	NSS
4.	CS2704/CS4702	Mobile and Wireless Network Security	3	0	2	4	NSS
5.	CS2705/CS4703	Distributed Algorithm Design	3	0	2	4	CIS
6.	CS2706	Agile Software Development and Modern Practices	3	0	2	4	CIS

Department Elective Course - IV (DEC-IV)

Sr. No.	Course Code DEC-IV/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2707	Advances of Intelligent and Learning Agents	3	0	2	4	AI& ML
2.	CS2708/CS4704	Advanced Artificial Intelligence	3	0	2	4	AI& ML
3.	CS2709/CS4705	Wireless Sensor Networks	3	0	2	4	NSS
4.	CS2710	Mobile Computing	3	0	2	4	NSS
5.	CS2711	Digital Image Processing	3	0	2	4	CIS
6.	CS2712/CS4706	Cloud Computing	3	0	2	4	CIS

Department Elective Course - V (DEC-V)

Sr. No.	Course Code DEC-V/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2801	Computational Genomics	3	0	2	4	AI& ML
2.	CS2802/CS4801	Computer Vision	3	0	2	4	AI & ML
3.	CS2803	Bioinformatics	3	0	2	4	AI&ML
4.	CS2804/CS4802	Advanced IOT with SDN (Industry 4.0)	3	0	2	4	NSS
5.	CS2805	Computer Crime Investigation and Forensics	3	0	2	4	NSS
6.	CS2806	Advanced Computer Architecture	3	0	2	4	CIS
7.	CS2807/CS4803	Recommender System	3	0	2	4	CIS
8.	CS2808	Advanced Algorithm Design and Analysis	3	0	2	4	CIS

V. List of Major Specialization Courses – 16 credits

Sr. No.	Course Code DEC/Major Spec.	Course Name	L	T	P	Credits	Category	Specialization domain
1.	CS2501/CS4501	Machine Learning	3	0	2	4	DEC-I	AI& ML
2.	CS2702/CS4701	Deep Learning	3	0	2	4	DEC-III	AI& ML
3.	CS2708/CS4704	Advanced Artificial Intelligence	3	0	2	4	DEC-IV	AI& ML
4.	CS2802/CS4801	Computer Vision	3	0	2	4	DEC-V	AI& ML
					Total Credits	16		
1.	CS2504/CS4502	Wireless & Mobile Networks	3	0	2	4	DEC-I	NSS
2.	CS2704/CS4702	Mobile and Wireless Network Security	3	0	2	4	DEC-III	NSS
3.	CS2709/CS4705	Wireless Sensor Networks	3	0	2	4	DEC-IV	NSS
4.	CS2804/CS4802	Advanced IOT with SDN (Industry 4.0)	3	0	2	4	DEC-V	NSS
					Total Credits	16		
1.	CS2505/CS4503	Introduction to Information Science	3	0	2	4	DEC-I	CIS
2.	CS2705/CS4703	Distributed Algorithm Design	3	0	2	4	DEC-III	CIS
3.	CS2712/CS4706	Cloud Computing	3	0	2	4	DEC-IV	CIS
4.	CS2807/CS4803	Recommender System	3	0	2	4	DEC-V	CIS
					Total Credits	16		

- **Major Specialization:**
  Major Specialization will be given to a student who earns 16 credits (within 160 credits) in any one domain of Department Elective Courses (DEC) offered by the CSE department.

VI. List of Open Elective Courses* – 24 credits

Project (Compulsory Major Project) – Interdisciplinary – 6 Credits

Sr. No.	Course Code OE/MSC	Course Name	L	T	P	Credits	Category
Semester III							
1.	CS6301/CS5301	Data Structures*	3	0	2	4	OE-I
Semester IV							
2.	CS6401/CS5401	Analysis and Design of Algorithms*	3	0	2	4	OE-II
Semester VII							
3.	CS6701/CS5701	Computer Networks*	3	0	2	4	OE-III

4.	CS6702	Computer Architecture & Organization*	3	0	2	4	OE-IV
Semester VIII							
5.	CS6801/CS5801	Operating systems*	3	0	2	4	OE-V
6.	CS6802	Software Engineering*	3	0	2	4	OE-VI
					Total Credits	24	

*Open Elective courses will not be offered to B.Tech. (CSE) students

VII. List of Minor Specialization Courses* (MSC) – 16 credits

Sr. No.	Course Code OE/MSC	Course Name	L	T	P	Credits	Category
Semester III							
1.	CS6301/ CS5301	Data Structures*	3	0	2	4	OE-I
Semester IV							
2.	CS6401/ CS5401	Analysis and Design of Algorithms*	3	0	2	4	OE-II
Semester VII							
3.	CS6701/ CS5701	Computer Networks*	3	0	2	4	OE-III
Semester VIII							
4.	CS6801/ CS5801	Operating Systems*	3	0	2	3	OE-V
					Total Credits	16	

*Minor Specialisation Courses (MSCs) will not be offered to B.Tech. (CSE) students

- **Minor Specialization:** Minor Specialization in CSE will be given to a student of outside the CSE department who earns 16 credits (within 160 credits) from the basket of Open Elective Courses offered by the CSE department as Minor Specialization Courses (MSC).

VIII. Internship (Optional) / Course Work – 12 credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester VI							
1.	CS8601	Internship Training (Optional)	0	0	24	12	Internship
					Total Credits	12	

(OR)

Sr. No.	Course Code	Course Name	L	T	P	Credits	Specialization Domain
Semester VI							
Students Opting for course work will do department elective (4 credits), open elective (4 credits) and Project Work (4 Credits)							
Department Elective (DE) – 4 Credits							

1.	CS2601	Knowledge Representation and Reasoning	3	0	2	4	AI& ML
2.	CS2602	Advanced Computer Networks	3	0	2	4	NSS
Open Elective (OE)* – 4 Credits							
1.	CS6601	Data and Communication Networks*	3	0	2	4	OE
2.	CS6602	IT concepts in Engineering*	3	0	2	4	OE
Project Work – 4 Credits							
1.	CS7601	Project Work	0	0	8	4	Project
Total Credits: 12							

*Open Elective course will not be offered to B.Tech. (CSE) students

IX. List of Non-Academic Courses (NAC) – 10 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester I							
1.	OR1101	Orientation Course (2 Credits) (including Introduction to Discipline Engg -1 credit 14 hours) (iii) Orientation (iv) Introduction to Computer Science and Engineering	1	0	0	1 1	NAC
Semester III							
2.	CS7301	Industrial Tour				2	NAC
Semester IV							
3.	PC7401	Proficiency-I				2	NAC
Semester VIII							
4.	CS8801	Discipline				2	NAC
5.	PC7801	Proficiency-II				2	NAC
					Total Credits	10	NAC

X. List of Departmental Honours Courses (DHC) – 16 Credits

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
Semester IV							
1.	CS3401	Database Systems	3	0	2	4	DHC-1
Semester V							
2.	CS3501	Compiler Design	3	0	2	4	DHC-2
Semester VII							
3.	CS3701	Special Topics in Wireless and Mobile Networks	3	0	2	4	DHC-3
Semester VIII							
4.	CS3801	Computational Cognitive Science	3	0	2	4	DHC-4
					Total Credits	16	

- **Honours:** To get Honours in CSE, the student will have to complete additional 16 credits (over and above 160 credits) of Department Elective Courses (DEC) of CSE department offered as Department Honours Courses (DHC).

E. SEMESTER WISE UG SCHEME TO BE IMPLEMENTED W.E.F. 2020-21 SESSION

Semester wise UG Scheme to be implemented w.e.f. 2020-21 session

SEMESTER-I		
S.No.		**Credits**
1	Orientation (including Introduction to Discipline course-1 credit 14 hours)	2
2	BSC-I (Mathematics)	4
3	BSC-II/ BSC-IV (Physics/ Chemistry)	4
4	GSC-I & GSC-II/ ESC-I	4
5	HSM-I/ ESC-II	3
6	ESC-III/ ESC-IV	3 / 2
	TOTAL	**20 / 19**

SEMESTER-II		
S.No.		**Credits**
1	BSC-III (Mathematics)	4
2	BSC-IV/ BSC-II (Chemistry/ Physics)	4
3	ESC-I/ GSC-I & GSC-II	4
4	ESC-II/ HSM-I	3
5	ESC-IV/ ESC-III	2 / 3
6	ESC-V/ ESC-VI	2
	TOTAL	**19/ 20**

SEMESTER-III		
S.No.		**Credits**
1	ESC-VII/ HSM-II	3
2	Deptt Core Courses (DCC)	12
3	OE-I	4
4	Industrial Tour	2
	TOTAL	**21**

SEMESTER-IV		
S.No.		**Credits**
1	HSM-II/ ESC-VII	3
2	Deptt Core Courses (DCC)	12
3	OE-II	4
4	Proficiency-I	2
	TOTAL	**21**

SEMESTER-V		
S.No.		**Credits**
1	DEC-I	4
2	Deptt Core Courses (DCC)	12
3	DEC-II	4
4	Minor Project	3
	TOTAL	**23**

SEMESTER-VI		
S.No.		**Credits**
1	**Internship Training (Optional)**	12
	Students opting for course work will do Deptt. Elective (4 credits), Open Elective (4 credits) and Project Work (4 credits)	
	TOTAL	**12**

SEMESTER-VII		
S.No.		**Credits**
1	HSM-III	3
2	DEC-III	4
3	DEC-IV	4
4	OE-III	4
5	OE-IV	4
6	Major Project-I	2
	TOTAL	**21**

SEMESTER-VIII		
S.No.		**Credits**
1	HSM-IV	3
2	DEC-V	4
3	OE-V	4
4	OE-VI	4
5	Discipline	2
6	Proficiency-II	2
7	Major Project-II	4
	TOTAL	**23**

ABBREVIATIONS		
	Basic Science Course	BSC
	Engineering Science Course	ESC
	General Science Course	GSC
	Humanities, Social Sciences & Mgmt.	HSM

ABBREVIATIONS		
	Department Core Course	DCC
	Department Elective Course	DEC
	Open Elective Course	OE

Total Credits = 160 without Honours **Total Credits = 160 + 16 with Honours**

Note: Minor Specialization will be given to a student who earns 16 credits from the basket of Open Elective courses offered by any one department (outside the parent department). Major Specialization will be given to a student who earns 16 credits in any one domain of Department Elective courses offered by parent department. To get Honours, the student will have to complete additional 16 credits of discipline Electives.

ESC-I	Introduction to Computing
ESC-II	Engineering Drawing with CAD Software
ESC-III	Introduction to Mechatronics
ESC-IV	Introduction to Electronics & electrical Engineering
ESC-V	Introduction to Manufacturing
ESC-IV	Strength of Materials
ESC-VII	Artificial Intelligence & Machine Learning
ESC-VII and HSM-II (in 3rd and 4th semesters) are common to all branches.	

Detailed Syllabus

Semester I

Semester I

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	OR1101	Orientation Course (2 Credits) (including Introduction to Discipline Engg -1 credit 14 hours) (i) Orientation (ii) Introduction to Computer Science and Engineering	 1	 0	 0	 1 1	NAC
2.	MA1101	Calculus and Ordinary Differential Equations	3	1	0	4	BSC-I
3.	CH1101	Applied Chemistry-I	3	0	2	4	BSC-IV
4.	ES1101	Introduction to Computing*	3	0	2	4	ESC-I
5.	ES1201	Engineering Drawing with CAD Software	2	0	2	3	ESC-II
6.	ES1301	Introduction to Mechatronics	2	0	2	3	ESC-III
					Total Credits	20	

*Common to all branches

Orientation Course (OR1101) of 2 credits includes Introduction to Discipline Engineering of 1 credit – 14 hours

Course Name	**:**	**Introduction to Computer Science and Engineering**
Course Code	**:**	
Credits	**:**	**1**
L T P	**:**	**1 0 0**

Total No. of Lectures – 14

Course Objectives:

The students should know about various disciplines in Computer Science and Engineering and are aware of emerging trends of Computer Science and Engineering.

Lecture wise breakup		**No. of Lectures**
1	**COMPUTER HARDWARE** Basics of Number System, Evolution of Computer Hardware, Moore's Law.	**2**
2	**LOGIC DEVELOPMENT AND ALGORITHMS** Various techniques to solve a problem, Ways to specify an algorithm.	**2**
3	**VARIOUS DISCIPLINES OF COMPUTER SCIENCE AND ENGINEERING** Basics of Operating Systems, Artificial Intelligence, Computer Networks, Information Security, Software Engineering, Computer Vision.	**6**
4	Current and future trends and challenges in various fields of computing. Social, ethical and economic issues related to computing technology. Exploration of career and professional development opportunities.	**4**

Course Outcomes:

At the end of the course, students will have:	
1	Students get knowledge about various fields of Computer Science and Engineering.

Suggested books		**Year of Publication/ Reprint**
1	Computing Fundamentals, Peter Nortan, 4th Ed., Tata McRaw Hill	Latest edition
2	Computer Science Handbook, Allen B. Tucker, CRC Press	Latest edition

Course Name	**:**	**Calculus and Ordinary Differential Equations**
Course Code	**:**	**MA1101 (Common to all branches)**
Credits	**:**	**4**
L T P	**:**	**3-1-0**
Total No. of Lectures	**:**	**42**

Course Objectives:
At the end of the semester, the students should be able to

1	understand the behavior of infinite series and their use.
2	learn the concepts related to differential calculus of functions of several variables and their applications.
3	learn the concept and methods of evaluating multiple integrals and their applications to various problems.
4	learn the methods to solve ordinary differential equations of various types.

	Lecture wise breakup	**No. of Lectures**
1	**INFINITE SERIES** Infinite series and convergence, alternating series, power series and convergence. Taylor's and Maclaurin's Series. (Scope as in Chapter 8, Sections 8.1, 8.3 – 8.9 of Text Book1).	8
2	**DIFFERENTIAL CALCULUS** Limit, Continuity and Partial Derivatives; Euler's Theoem for Homogeneous functions; Differentiability, Linearization and Differentials; Chain rule; Extreme values and Saddle Points; Lagrange multipliers; Taylor's Formula**. (**Scope as in Chapter 12, Sections 12.1 – 12.6, 12.8 – 12.10 of Text Book 1).	12
3	**INTEGRAL CALCULUS** Cylinders and Quadric surfaces, Double integrals in Rectangular and Polar form, Triple integrals in Rectangular, Cylindrical and Spherical Coordinates, Substitutions in Multiple integrals. Applications to practical problems. (Scope as in Chapter10, Sections10.6 and 10.7 and Chapter 13, Sections 13.1, 13.3, 13.4,13.6 and 13.7 of Text Book 1).	10
4	**ORDINARY DIFFERENTIAL EQUATIONS** First order exact differential equations, Integrating factor, Orthogonal trajectories, Second and Higher order Linear Differential Equations with constant coefficients, Differential Operators, Methods of Variation of Parameters and Undetermined Coefficients, Euler Cauchy Equation, Wronskian. (Scope as in Chapter 1, Section 1.5, 1.8 Chapter 2, 2.1-2.4, 2.6, 2.9-2.10, 2.13- 2.15 of Text Book 2).	12

Course Outcomes:
At the end of the semester, the students are able to

1	test the behavior of infinite series.
2	Apply the concepts of differential calculus of functions of several variables.
3	evaluate multiple integrals and apply them to practical problems.
4	solve ordinary differential equations of various types

Text Books:

1	Calculus and Analytic Geometry, Thomas and Finney, 9th edition, Pearson Education Asia.	2006
2	Advanced Engineering Mathematics, Kreyszig, 8th edition, John Wiley and Sons.	**2005**

Reference Books:

1	**Differential Equations, Frank Ayers, SI edition, Mc Graw Hill.**	**1972**
2	Advanced Engineering Mathematics, Wylie and Barrett, 6th edition, Mc Graw Hill.	**2003**

Course Name	**:**	**Applied Chemistry I**
Course Code	**:**	**CH1101 (For Electrical, ECE and CSE)**
Credits	**:**	**4**
L T P	**:**	**3 -0-2**

Total No. of Lecture-42

Objective: To teach the fundamentals and application of chemical sciences essential for the development of electrical and electronic materials and technologies. Students will be learning various analytical techniques for the characterizations of electronic organic/inorganic materials.

Lecture wise breakup	***No. of Lectures = 42***

1	**Fundamentals for Applied Chemistry** Molecular orbital theory, Jahn-Teller Effect in Crystal Field Theory, Solid state chemistry: Crystal defects and line imperfections, Reaction mechanism in organic chemistry: Principles and methods of determination, Chemical Kinetics: Langmuir–Hinselwood Mechanism, acid-base equilibria in non aqueous media, Introduction to Computational chemistry and open source softwares	**(10)**
3	**Polymeric Materials** Mechanism and methods of polymerization, structure-activity relationship, Conducting Polymers: types (n- or p- doping) and applications, Polymeric fibre materials	**(6)**
4	**Energy Storage and Sensing Devices:** Fundamentals of Electrochemistry, types of electrodes, Reference electrodes, Ion-selective electrodes, Fuel cells, Batteries (Lithium-ion Batteries and EV Batteries), Renewable energy (Artificial photosynthesis), Solar cells, Sensors for IoT	**(8)**
5	**Spectroscopic Methods for structural Analysis:** Principle and applications (UV, IR, NMR, SEM and TEM)	**(9)**
6	**Chemistry of Electronic and Electrical Materials** Semi-conductor and super conducting Materials, Carbon materials, Optical Materials (OLED), 2D Materials, Magnetic materials.	**(9)**

Practicals	
Sr. No.	**Name of Experiment**
1.	Synthesis of metal-complex and determination of melting point
2.	Implementation of IR technique for the analysis of metal-complex synthesized
3.	Preparation of Metal-oxide by sol gel and hydrothermal method
4.	Characterization of metal–oxide using SEM technique by structural determination
5	Synthesis of an organic compound and chemicals analysis.
6	Structural analysis of organic compound by NMR technique.
7	Synthesis of polymer material and its analysis.
8	Application of UV spectroscopy for polymer functional group analysis
9	Investigation of redox chemistry of an inorganic material by Cyclic Voltammeter.
10	Application of open source software for chemical analysis and drug design.

Outcomes: 1. To be able to apply the fundamentals of chemistry towards developing new Technologies based on new materials.

2. To attain the essential analytical skills and designing of materials for electrical and electronic applications.

3. Application of softwares as important tools in technological applications.

Books:

1. Concise Inorganic Chemistry, by J. D. Lee, 5th Edition, 2003 (Chapman & Hall).
2. Organic Chemistry by S. M. Mukherji, and S. P. Singh, 2017 (Newagepublishers).
3. Principles of Physical Chemistry by Puri, Sharma and Pathania, 2008 (W.H. Freeman & Co).
4. Atkin's Physical Chemistry by Peter Atkins, Julio de Paula, 7th Edition (Oxford University Press).
5. Principle of Polymerization by G. Odian, 4th Edition, (John Wiley & Sons, Inc.).
6. D. S. Pavia, G.M. Lasmpman and G.S. Kriz: Introduction to Spectroscopy, 4th Edition, (Thomson learning, Indian Edition).
7. Computational chemistry: Introduction to theory and applications of molecular and quantum mechanics: Lewars Errol G. (Springer)
8. NPTEL web lectures: Chemistry of Materials, Engineering Chemistry I & III.

Course Name	**:**	**Introduction to Computing**
Course Code	**:**	**ES1101 (Common to all branches)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objective:
To develop logical skills so that students should be able to solve basic programming problems. To use programming knowledge to develop small projects including basic GUI design

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION TO PROGRAMMING** Evolution of languages: Machine languages, Assembly languages, High-level languages. Software requirements for programming: System softwares like operating system, compiler, linker, loader; Application softwares like editor. Flowcharts. Algorithm, specification of algorithm. Industrial uses of programming in various domains	**3**
2	**DATA TYPES and OPERATORS AND EXPRESSION** Storing integers, numbers with decimals, characters and strings, typecasting. User input and output, use of command line arguments Operators:arithmetic operators, relational operators, logical operators, bitwise operators, miscellaneous operators. Expressions and their evaluation. Precedence and associativity rules.	**7**
3	**ITERABLE CONTAINERS and STATEMENTS** List, set, tuple and dictionaries; range function; difference between various iterable containers Decision making statements: if, if-else, nested if and if-else. Control statements: for & while loops, nested loops; Role of statements like break, continue	**7**
4	**FUNCTIONS and CLASSES** Advantage of modularizing program into functions, function definition and functioninvocation. Function arguments: default, keyword and positional arguments. Scope and lifetime of a variable. Recurrence relations and Recursion Advantage of using classes, defining class data members & functions and accessing using objects. Constructors and destructors in a class, parameterized constructors	**8**
5	**GUI design** Introduction to tkinter library, use of TK &mainloop methods, use of widgets like Button, Canvas, Checkbutton, Entry, Frame, MenuButton, Listbox, Menu, Scrollbar, Text, Message, Pack, Grid, place etc. for GUI design	**5**
6	**SORTING AND SEARCHING** Searching: Linear search, binary search and hash search. Sorting: Insertion sort, selection sort, bubble sort, quick sort, merge sort, heap sort, and Bucket sort. Time and space complexity of algorithms, comparing algorithms	**9**
7	**Problem Solving** Real-world programming problems	**3**

Total no. of turns: 14

List of Experiments:	
1	Implement programs to input/output various data types
2	Implement programs to use command line arguments
3	Implement programs making use of various operators
4	Implement programs making use of conditional statements and loops

5	Implement programs making use of iterable containers
6	Implement programs making use of functions and recursion
7	Implement programs performing file operations
8	Implement various searching and sorting algorithms
9	Project work including GUI design using tkinter

Course Outcomes: At the end of the course, students will be able to:	
1	Develop understanding ofthe fundamental concepts essential for programming.
2	Make efficient use of iterables, function and classes to programming problems
3	Develop simple GUI applications
4	**Learn to compare algorithms and improve efficiency of algorithms**

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Think Python, How to Think Like a Computer Scientist, Version 2.0.17 Allen Downey Green Tea Press Needham, Massachusetts	2012
2	Python Programming: An Introduction to Computer Science by John M. Zelle, Franklin, Beedle& Associates Inc	2015
3	Core python programming, Dr. R. Nageswara Rao, 2nd edition, Dreamtech press	2018

Course Name	Engineering Drawing with CAD Software
Course Code	ES1201 **(Common to all branches)**
Credits	3
L TP	2-0-2
Total No. Lectures	**28**

Course Objectives:

At the end of this course, the student should be able to understand the basic concepts of Engineering Drawing. The student should be able to visualize and draw the two- and three-dimensional objects. The student should also be able to understand the features associated with operations of the computer-aided design (CAD) software.

Total No. of Lectures – 28

Lecture wise breakup		Number of Lectures
1	Introduction to Engineering Graphics, Concept of points and lines, System of Projections, Orthographic projections, Dimensioning.	4
2	Introduction to different types of CAD Softwares e.g. SolidWorks/AutoCAD/ CATIA etc., 2D-Sketching, Sketching Entities & Relation, 3D-Sketching, Editing and its Features, Dimensions, Sketch Tools, File handling	7
3	Projections of planes / lamina on reference planes, classification of primary and secondary planes, use of auxiliary planes, Exercises using CAD software	5
4	Classification of solids, Projections of solids on the basis of positions of the axis of various solids on reference planes and Sectioning of solids, Exercises using CAD software	6
5	Introduction to Perspective projection, isometric views, Isometric lines & Axes, conversion of orthographic views to isometric views and vice-versa, Exercises using CAD software	6

List of Experiments:		Number of Turns
Exercises to be done using CAD software		
1	2D & 3D Sketching using various sketching tools.	2
2	Projection of planes.	2
3	Developments of 3D-parts.	2
4	Projection of solids.	2
5	Projection of Sectioning of solids.	2
6	Isometric and orthographic views.	2
7	Generating drawings of 3D-parts.	2

Course Outcomes: At the end of this course, the students will be able to:	
1	Understand the basic concepts of Engineering Graphics.
2	Visualize the actual objects and convert them in to readable drawings.
3	Understand the drawing standards, conventions and symbols that are in common usage.
4	Draw the common Engineering drawings using available Drafting softwares.
5	Come up with innovative conceptual ideas by using Drafting softwares.

Suggested Books:		
Sr. No.	Name of Book/ Authors/ Publisher	**Year of Publication/ Reprint**
1	Engineering Drawing, P. S. Gill, S.K. Kataria& Sons.	2012
2	Engineering Drawing, D.A. Jolhe, Tata McGraw Hill	2010
3	Engineering Graphics with SOLIDWORKS, David C. Plan chard, SDC Publications	2020

Course Name	**:**	**Introduction to Mechatronics**
Course Code	**:**	**ES 1301 (Common to all branches)**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:

The objective of the course content is to:
CO1:Impart knowledge and information about product design.
CO2:Development and control of intelligent systems for all aspects of life.

Lecture wise breakup		**No. of Lectures**
1	**Understanding Mechatronics** Mechatronics System, Evolution, Definitions of Mechatronics, Key Elements of Mechatronics, Mechatronics for all Civil, Metallurgical, Aerospace, Chemical, Architecture, Medical, Robotics, Defense, Agriculture, etc., Role of Mechanical, Electrical, Electronics, Computer Engineers in Intelligent Product and Process Design, Development and Control, Bio-mechatronics.	02
2	**Systems and Machines :** System, Classification of System, Mechanistic System Classification Based on Input Energy, Mathematical Model and Function, Machine, Parts of Machine, Concepts of Machine, Classification of Machines based on Function and Size.	02
	System Intelligence: Properties of Intelligent System, System Intelligence Levels, Human Intelligence System, Future Generation System Intelligence Level, Expressing System Intelligence.	02
3	**Sensor and Transducer :** Sensors in Mechatronics System, Difference between Sensors and Transducers, Classification of Sensors, Based on Sensor Output Signal, Sensor Input Physical Parameters, Sensor Accuracy (Smart/Intelligent Sensor), Performance Terminology, Static Characteristics, Dynamic Characteristics.	03
4	**Signal Conditioning Devices :** Signal Conditioning Processes,Application of Signal Conditioning Devices in Mechatronics based on Their Characteristics such as Diode, Transistor, SCR, DIAC, TRIAC, Op-Amps, Signal Filtering, Circuit Protection, Signal Conversion, ADC and DAC, Logic Gates, Flip-Flops, Register, Counters.	05
5	**Actuators:** Actuators, Types of Actuators, Mechanical Actuation System (i.e. Linear-rotary, Rotary-linear Mechanism, Gear, Bearing, Pulleyetc.). Electrical Actuation System (DC, AC, Stepper Motors), Pneumatic and Hydraulic Actuation System.	05
6	**Controllers :** Microprocessor, Microcontroller, PLC Controller& Their Architectures, Principles and Working Software Programs (Assembly/High Level),Interfacing Aspects, Application Examples.	05
7	**Robotics and Automation:** Evolution of Robots, Definitions, Types of Motions, Function, Governing Laws, Classification, Features and Components of Robots, System Automation .	04
	Total No. of Lectures	28

LIST OF EXPERIMENTS		
	Number of Turns	
1	**Experiment on Sensors & Transducers (Mechatronics Lab)**	
(i)	To study the characteristics of LVDT using linear displacement trainer Kit & compare with ideal characteristics.	01
(ii)	To measure the strain of the metal strip using strain gauge trainer kit & compare with ideal characteristics.	01

(iii)	To measure the angular displacement of resistive & capacitive transducer using angular displacement trainer kit & compare with ideal characteristics.	01
(iv)	To obtain the characteristics of RTD, Thermistor, thermocouple with hot and cold junction thermal trainer kit & compare with ideal characteristics.	01
2.	**Experiments on Signal Conditioning**.	
(a)	Experiments on Analog Devices	
(i)	PN Junction Diode	01
(ii)	Zener Diode	01
(iii)	Half wave rectifier	01
(iv)	Full wave rectifier	01
(b)	**Experiments on Digital devices**	
(i)	Logic Gates (AND, OR, NAND, NOR etc)	01
(ii)	Flip Flop (RS Flip Flop), D Flip Flop.	01
3	**Experiments on Controller**	01
(i)	Study of microprocessors, microcontroller, programmable logic controller (PLC)	
(ii)	PLC interfacing of I/O and I/O addressing.	01
(iii)	To perform any basic sequence programming using PLC.	01
4.	**Experiments on Actuators**	01
(i)	Study of mechanical, electrical, hydraulic/pneumatic actuators.	

Course Outcomes:

	By the end of this course, the student will be able: CO1: To understand components of mechatronic system, CO2: To design product and systems theoretically as well as practically with intelligence.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Mechatronics First edition by Tilak Thakur, published by Oxford University Press	2016
2	Mechatronics, Fourth edition, by W Bolton. ISBN 978-81-317-3253-3	2013
3	Dan Necsulescu Mechatronics published by Pearson Education (Singapore) Pvt. Ltd., Indian Branch, 482 FIE, Patparganj, Delhi India.	2001
4	Book by H M T Limited, Mechatronics Tata McGraw Hill Publishing Company Limited, New Delhi.	1988
5	Mechatronics Principles, Concepts & Applications by Nitaigour P Mahalik published by TMH	2003

Semester II

Semester II

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	PY1201	Electromagnetic Theory and Quantum Physics	3	0	2	4	BSC-II
2.	MA1301	Probability and Statistics	3	1	0	4	BSC-III
3.	ES1401	Introduction to Electronics & Electrical Engineering	2	0	0	2	ESC-IV
4.	ES1501	Introduction to Manufacturing	2	0	0	2	ESC-V
5.	GS1101 & GS1201	Introduction to Environmental Sciences – I Introduction to Environmental Sciences - II	2 1	0 0	0 2	2 2	GSC-I & GSC-II
6.	HS1101	Communication Skills & Ethics	2	0	2	3	HSM-I
					Total Credits	19	

Course Name	**:**	**Electromagnetic Theory and Quantum Physics**
Course Code	**:**	**PY1201 (For CSE, ECE, Elecrical)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**

Course Objectives:

1. To familiarize the students with the concepts of electrostatics and boundary value problems.
2. To make the students able to understand the magnetostatics and their boundary value problems.
3. To make the students able to understand and apply the concepts of electromagnetic wave propagation.
4. To familiarize the students with the concepts and principles of Quantum Mechanics.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**VECTORS, FIELDS AND ELECTROSTATICS:** Cartesian coordinate System, Cylindrical and Spherical coordinate Systems, Gradient, Divergence of a Vector and Divergence Theorem, Curl of a vector and Stoke's theorem, Gauss's law & its applications, Maxwell's 1st eqn. (Electrostatics), Electric Energy and potential, Potential gradient, the dipole fields, Energy density in an electrostatic field. Current and current density, Continuity of current, Metallic conductors, Dielectric materials, Electrostatic boundary-value problems, Laplace's and Poisson's equations.	12
2	**MAGNETOSTATICS:** Biot-Savart's law, Ampere's circuital law, Magnetic flux and magnetic flux density, Scalar and vector magnetic potentials. Magnetic dipole, Force due to Magnetic field on a differential current element, force between two differential current elements, Force and torque on a closed circuit, magnetic materials, Magnetic boundary conditions, Inductors and inductances,	10
3	**MAXWELL'S EQUATIONS AND ELECTROMAGNETIC WAVE PROPAGATION:** Faraday's law, Displacement current, Maxwell's equations in point form, Maxwell's equations in integral form, EM waves in general, EM wave propagation in Lossy Dielectrics, Wave propagation in lossless dielectrics, Plane waves in free space, Plane waves in Good conductors, Power & Poynting Vector, Reflection of a plane wave at normal incidence.	10
4	**QUANTUM PHYSICS:** Need of Quantum theory, Photoelectric effect, The Compton effect; matter waves, group and phase velocities; Uncertainty principle and its application; time independent and time dependent Schrödinger wave equation; Eigen values and Eigen functions, Born's interpretation and normalization of wave function, applications of Schrödinger wave equation for particle in one dimensional infinite potential well. Introduction to nanoscience	10

List of Experiments:		**Number of Turns**
1	Familiarization of students with basic instruments Vernier Calipers, Screw Gauge and Spectrometer.	1
2	To study dielectric constant and Curie temperature of Ferroelectric ceramic BaTiO3.	1
3	To study the ratio of electron charge to mass ratio in uniform magnetic field.	1
4	To determine coercivity of magnetic material using hysteresis loop tracer.	1
5	To study the Hall effect and to determine Hall Voltage (V_H) and Hall coefficient (R_H)	1
6	To determine the energy band gap of semiconductor (Ge) using Four Probe Method.	1
7	To design a method to draw equipotential lines with various geometries of electrodes kept at different potentials.	1

8	To study the variation of magnetic field with distance along the axis of current carrying circular coil using Stewart and Gee's apparatus.	1
9	To plot I-V Characteristics of Solar cell.	1
10	To determine magnetic susceptibility of paramagnetic sample using Quink's tube method.	1
11	To determine the flashing and Quenching Potential of neon/Argon and also to find the capacitance of unknown capacitor.	1

Course Outcomes:By the end of the course	
1	Students will be equipped with the tools of electromagnetic theory.
2	Students will be able to solve numerical problems based on electrostatics, magnetostatics, electromagnetic wave propagation.
3	Students will be able tounderstand and apply the basic concepts of Quantum Mechanics.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Yearof Publication/ Reprint**
1	Engineering Electromagnetics, William H Hyat, Jr., and John A. Buck, Tata McGraw Hill	2013 / 5th edition
2	Elements of Engineering Electromagnetics, Matthew N.O. Sadiku, Oxford University Press	2012 / 4th edition
3	Concepts of Modern Physics, Arthur Beiser, McGraw Hill Education (India) Pvt. Ltd., New Delhi.	2013
4	Modern Physics, J. Bernstein, P.M. Fishbane and S.G. Gasiorowicz, Pearson, Education India Pvt. Ltd., New Delhi	2009

Course Name	**:**	**Probability and Statistics**
Course Code	**:**	**MA1301 (For CSE, Electrical, Metta, Prod and student-specific for Civil)**
Credits	**:**	**4**
L T P	**:**	**3-1-0**
Total No. of Lectures	**:**	**42**

Course Objectives:
At the end of the semester, the students should be able to

1	understand the concepts of random variable and probability distribution.
2	learn the concepts of some theoretical probability distributions .
3	understand the concept of sampling distribution and be able to construct and interpret confidence interval estimates for the mean , proportion , difference of mean and proportion
4	learn to use various tests of hypotheses

	Lecture wise breakup	**No. of Lectures**
1	**RANDOM VARIABLES** **Random variables, Discrete, Continuous and Joint Probability distributions, Marginal and Conditional distributions, Independent random variables, Expectation, Variance and Covariance, Means and variances of linear combinations of random variables, Chebyshev's inequality**	10
2	**PROBABILITY DISTRIBUTIONS** **Binomial, Poisson, Uniform and Normal distributions, Normal and Poisson approximations to Binomial, Moments, Moment generating function.**	10
3	**SAMPLING DISTRIBUTIONS** **Population, Sample, Sampling distributions, Central limit theorem, Distribution of sample mean, Difference of means, Proportions and difference of proportions, Chi-square distribution, Student's t-distribution.**	7
4	**ESTIMATION** **Estimation of parameters, Point estimate, Confidence interval for mean, difference of means and proportions.**	6
5	**TESTS OF HYPOTHESES** **Hypothesis, Test statistic, Critical region, Significance level, Single Sample and Two Samples Tests for mean and proportion.**	9

Course Outcomes:
At the end of the semester, the students are able to

1	understand the concepts of random variable and probability distribution.
2	apply the concepts of some theoretical probability distributions .
3	use the concept of sampling distribution and apply tests of significance to practical problems of engineering
4	apply various tests of hypotheses

Text Books:

1	Probability and statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, 7th edition, Pearson Education	2006

Reference Books:

1	**Miller and Freund's: Prabability and Statistics for Engineers, Richard A. Johnson, C.B. Gupta, Pearson Education.**	**2006**
2	**John E. Freund's: Mathematical statistics with Application, Miller and Miller, Pearson Education.**	**2004**

Course Name	**:**	**Introduction To Electronics & Electrical Engineering**
Course Code	**:**	**ES1401 (Common to all branches)**
Credits	**:**	**2**
LTP	**:**	**2-0-0**

Course Objective:
To introduce to the students, the fundamental concepts of electronic devices, circuits and electrical systems for engineering applications.

Total Number of Lecture:28

	Lecture wise breakup	Number of Lecture
1	**Semiconductor Device sand applications**: Familiarizations with active and passive components Physics of p-n junction diode, BJT, JFET and MOSFET, diode as Rectifier, clippers and clampers, Transistor as an amplifier, Introduction to Audio amplifiers, Functional operation of OpAmp, concept of Oscillators, filters and their types	7
2	**Digital Electronics**: Introduction to logic gates, combinational circuits: adder, subtractor, multiplexer, demultiplexer, sequential circuit: flipflops, counters, registers, Analog to digital conversion, Digital to analog conversion and applications	5
3	**Communication Systems:** Various frequency bands used for communication, Block diagram of Analog and Digital communication, need of modulation, Analog modulation techniques (Amplitude and frequency), Digital modulation techniques (ASK, FSK, PSK,)	3
4	**Fundamentals of Electrical Engineering:** Introduction to circuit laws, Network theorems, Amplitude, Phase, Phase difference, RMS value and Average value of a AC signal, Active and Reactive Power, single phase and 3 phase systems,star delta connection, construction, working principle and speed control of AC and DC machines, Transformer: construction, working principle and applications	8
5	**Measurements:** Principle of measurement, voltage, current, power and energy measurement, analog and digital measurement system	5

Course Outcomes: By the end of the course the students will be able to

1. Express the understanding of semiconductor devices (p-n Diode, BJT, MOSFET etc), and their applications.
2. Describe the functional operation of various analog and digital electronic circuits.
3. Solve basic electronic circuits using circuit laws and network theorems.
4. Describe the basic principle and working of fundamental electrical systems, ac dc motors and transformer etc.
5. Explain the basic principle of measuring electrical quantity such as voltage, current, power and energy.

SuggestedBooks:

Sr. No	NameofBook/Authors/Publisher	Year of Publication/ Reprint
1	Electronics Devices & Circuit Theory, RLBoylestead & LNashelsky(PHI)	2009
2	CircuitsandNetworks:AnalysisandSynthesis,SudhakarandShyamMohan,TMH	2009
3	ElectronicCommunicationSystemsbyG.Kennedy,McGrawHill,4thEdition	2008
4.	Digital Principles And Applications, Seventh Edition, A. Malvino and D. Leach	2011
5.	Alexander, Charles K., and Sadiku, Matthew N. O., Fundamentals of Electric Circuits, 5th Ed, McGraw Hill	2013
6.	A K.Sawhney-A course in Electrical and Electronic Measurements and Instrumentation	Latest Edition

Course Name	**:**	**Introduction to Manufacturing**
Course Code	**:**	**ES1501 (For Aero, CSE, ECE and Electrical)**
Credits	**:**	**2**
LTP	**:**	**2-0-0**

Total no. of lectures: 28

Course Objectives:
To equip the students with basic understanding and learning of its concepts for conventional and advanced manufacturing processes along-with their applications.

	Syllabus	**Hrs**
(1)	Concept of Manufacturability, Classification of Manufacturing processes -Introduction to Primary Manufacturing processes: Types and applications -Introduction to Secondaryand Tertiary Manufacturing processes: Types and applications.	6
(2)	Concept of Smart, Digital and Sustainable manufacturing processes with applications. Concepts of Industry 4.0 its relevance and Industrial Internet of Things (IIOT).	6
(3)	Introduction to Advanced Manufacturing practices: Classification, Principles and Applications of Electric Discharge Machining (EDM), Laser Beam Machining (LBM), Abrasive Flow Machining (AFM), Chemical and Electro Chemical Machining (ECM), Ultrasonic Machining and Welding etc.	6
(4)	Computer Integrated Manufacturing: Concept of CAD/ CAM. a) Concept of Additive and Subtractive manufacturing processes: Rapid Prototyping & Rapid Manufacturing, Principles, Major technologies used and its applications. b) CNC machines, concepts, uses and applications. c) Industrial Robots, types and applications.	6
(5)	Case studies and practical examples on: a) Manufacturing of small precision parts. b) Manufacturing of ICs & PCB. c) Manufacturing of keyboards and hardware.	4

Course Outcomes:	
1	Students would be able to classify and choose manufacturing processes for typical applications.
2	Understand the process, steps and applications of Rapid Prototyping
3	Understand the principles and applications of CNC and Robots in manufacturing.

REFERENCE BOOKS:

S. No.	**Title, author and Publisher**	**Publication year / Reprint**
(1)	Manufacturing Engineering & Technology, Kalpakjian and Shmid (Pearson Publications)	2013
(2)	Advanced Manufacturing Processes, VK Jain, Allied Publishers	
(3)	Introduction to Basic Manufacturing, CS Jawalkar, Narosa Publishers	2014 2016

Course Name	**:**	**Introduction to Environmental Sciences-I**
Course Code	**:**	**GS 1101 (Common to all branches)**
Credits	**:**	**2**
L T P	**:**	**2 0 0**

Total No. of Lectures – 28

Course Objectives:

1. This course aims to acquaint students with the basics of Environmental Sciences.
2. To make them understand the importance of Environmental Sciences.

Lectures with breakup **No. of Lectures**

S. No.	Unit wise breakup	No. of Lectures
1	Introduction to environmental studies: Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.	4
2	Ecosystems: What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems :a)Forest ecosystem b) Grassland ecosystem c)Desert ecosystem d)Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)	8
3	Natural Resources: Renewable and Non-Renewable Resources: Land resources and Landuse change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over--exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter--state).Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.	8
4	Environmental Pollution: Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management: Control measures of urban and industrial waste. Pollution case studies.	8

Course Outcomes:

1. Students will be able to relate the importance of Environmental Sciences for sustainable development of society
2. Students will be able to understand the problems and remedies of Environmental Sciences

Text Books:

1	Environmental Science Ceonage Learning Publications, Miller G.T. and Spool Mar
2	Environmental Studies, Tata Mcgraw Hill Pub., Banny Joseph
3	Text book of Environmental Studies for U.G. Courses - University Press – ErachBharucna
4	Environmental Studies – from criteria to cure, Oxford Univ. Press, R. Raogopalan

SUGGESTED BOOKS:

S. No.	Name of Book/Authors/Publishers	Year of Publications/Reprints
1.	"Building Construction Punmia B.C, Punmia Arun Jain & Ashok Jain, Laxmi Publication (P) Ltd.	2012
2.	"Estimation and costing in Civil Engineering'', B.N Dutta, UBS publisher distributors.	2014
3.	"Engineering Materials", S.C. Rangwala, Charotar Publishing House.	2016
4.	"Building Construction", P.C. Varghese, PHI learning Pvt Ltd.	2014
5.	"Building Construction", Mckay W. Barry, Pearson Publication.	2013

Course Name	**:**	**Introduction to Environmental Science-II (GSC-II)**
Course Code	**:**	**GS1201 (Common to all branches)**
Credits	**:**	**2**
L T P	**:**	**1 0 2**

Total No. of Lectures: 14

Course Objectives: This course aims to attract the attention of students towards understanding the chemistry of pollutants, their analysis and disposal along with introduction to green chemistry for Environment friendly processes and products.

	Contents	Lectures
1.	**Air Pollution:** Introduction, Air pollutants, Photochemical reactions in the atmosphere, Photochemical smog, Health effects and the usual ways to control air pollution	3
2.	**Water Pollution:** Types of Pollution, Contaminants and their sources, measurements and its control	3
3.	**Soil Pollution:** Inorganic and organic contaminants, Pesticides and herbicides, health effects and remedial measures, metal toxicology	3
4.	**Green chemistry for clean Technology:** Goals, Principles and applications	2
5.	**E-waste Management:** Introduction, Environmental impact/ health effects of e-waste exposure, Methods to dispose e-waste	3

Course Outcomes:

1. Students will be able to identify the source of contaminants in Water, Soil and Air and develop the strategies to minimize the levels of pollution
2. Students will understand the applications of green chemistry in mitigating the environmental pollution
3. Hands on training through lab experiments for chemical analysis of various pollutants.

Books:

1. Chemistry for Environmental Engineering and Science, Fifth Edition by Sawyer, McCarty and Parkin (Publisher: McGraw-Hill Education, 2003)
2. Environmental Chemistry, Seventh Edition by A.K. De (Publisher: New Age International (P) Limited, 2017)
3. Environmental Chemistry: Pollution and Remedial Perspectives by A.V. Salker (Publisher: Alpha Science International Limited, 2017)

Practicals	
Sr. No.	**Name of Experiment**
1.	Determination of total dissolved solid (TDS) by conductivity measurement
2.	Measurement of acid-base equilibria by pH meter in water/soil sample.
3.	Measurement of dissolved oxygen in given waste water sample
4.	Determination of organic pollutants (pesticides) in water/soil sample by extraction and IR analysis
5	Measurement of alkalinity and hardness in a given sample of water
6	Measurement of biological oxygen demand (BOD) in given sample of water
7	Measurement of chemical oxygen demand (COD) in given sample of water
8	Measurement of oil and greases in waste water by gravimetric analysis
9	Detection of heavy metal by complexation and UV-Visible spectrophotometer
10	Removal of toxic metals by chemical adsorption method

Course Name	**:**	**Communication Skills & Ethics**
Course Code	**:**	**HS1101 (Common to all branches)**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives :

1. The course aims to enhance communication skills and critical thinking skills of the students to further develop their personality so as to be more effective in personal and professional life.
2. The course further aims to provide basic knowledge in ethics, values, norms and standards to establish their importance in life and to enable students to self-assess and enhance their personality.

Total No. of Lectures – 28

Lecture-wise Breakup		**No. of Lectures**
1	**Introduction to Communication Process** Scope, Significance, Types, Levels and Tools of Effective Communication. Verbal, Vocal and Non-Verbal Skills	**(1)**
2	**Critical Thinking Skills** Developing Thinking Skills-Descriptive, Referential, Inferential, Discursive, Analytical, Evaluative, Creative and Lateral Using Texts and Various Media Forms:(Books, Newspaper Articles, Films, Social Visuals)	**(4)**
3	**Speaking Skills** Developing Speaking Skills PACESS-Governed (PACESS-Purpose, Audience, Content, Expression, Structure, Style) for Communication at Various Levels: Interpersonal, Group, Organization and Society	**(3)**
4	**Advanced Technical Writing** Job Application, E-mail, PACESS-Governed Short Essay, Memo, Notice, Agenda, Minutes, IMRD-BasedReport.	**(4)**
5	**Job Preparation** Sensitization to Building Portfolio, Resume, Interview Skills	**(2)**
6	**Introduction to Ethics** Concept, Nature, Scope, Functions and Factors influencing Ethics, Psycho-Social Theories of Moral Development – Kohlberg and Carol Gilligan, Broader Ethical Issues in Society (Research Based)	**(5)**
7	**Ethics and Business** Concept and Objectives of Business Ethics, Factors influencing Business Ethics, 3 C's of Business Ethics, Ethical Dilemmas in Business (Role- Play)	**(3)**

8	**Self-Awareness & Self-Development** Concept of Self Awareness, Self- Esteem, Self-Assessment – SWOT Analysis, Concept of Self-Development, Social Intelligence, Emotional Intelligence, Time and Stress Management, Positive Human Qualities (Empathy, Gratitude, Compassion, Forgiveness and Motivation), Personality Development Models – Johari Window, Myers Briggs Type Indicator Leadership Development	**(6)**

Total No. of Practical Sessions: 14

Practical Session Wise Breakup		**No. of Practical Sessions**
1	**Organizational Communication** Verbal, Vocal and Non-Verbal Communication at Various Levels, Self- Introduction, Speech, JAM	**(2)**
2	**Applying Critical Thinking Skills** Reading Comprehension, Book Review, Film Review, Social Visuals Interpretation and Critical Analysis .	**(4)**
3	**Speaking Techniques at Different Forums** Group Discussions, Making and Presenting Power Point Presentations	**(4)**
4	**Practice on Technical Writing** Job Application, Email, Memo, Notice, Agenda, Minutes, Report, Short Essay	**(3)**
5	**Towards Job Preparation** Sensitization to Building Portfolio, Resume, Interview	**(1)**

Course Outcomes:	
1	The students will gain greater proficiency in English language and its technical aspects for its effective use in personal and professional life.
2	The students will achieve greater refinement of personality through awareness and acquisition of forms and techniques of communication skills.
3	The students will be able to distinguish between right and wrong in both personal and professional life.

Suggested Books& E-Material		
S.No.	***Name of Book/ Authors/ Publisher***	***Year of Publication/ Reprint***
1	Technical Communication: Principles and Practices, III Edition, Meenakshi Raman and Sangeeta Sharma, OUP, NewDelhi (with E-Material)	2017
2	English for Writing Research Papers, Adrian Wallwork, Springer, London, New York	2011
3	Business Ethics – Text and Cases", Murthy C.S.V., 1st Edition, Pubs: Himalaya Publishing House.	2014

4	"Issues and Ethics in the Helping Professions", Corey G., Corey M.S. and CallananP., 8th Edition, Pubs: Brooks/Cole, Cengage Learning.	2010

	Reference Books and E-Materials	
1	Business Communication III Edition, RK Madhukar, Vikas Publication House Pvt. Ltd, Noida	2018
2	Body Language, Allan Pease, Sudha Publications Pvt Ltd., New Delhi	2004
3	Techniques of Writing Business Letter, Memos & Reports, Courtland L Bovee, Jaico Publishing House, Mumbai	2005
4	Bridging the Soft Skills Gap, Bruce Tulgan, Wiley, New Delhi	2005
5	A Guide to Gracious Living Etiquette & Life Skills, Jyoti Singh, Mohindra Publishing House	2017
6	TED Talks Videos on Ted.com (Not their Regional versions)	
7	"The Curse of Self: Self-awareness, Egotism and the Quality of Human Life", Leary M.R., 1st Edition, Pubs: Oxford University Press.	2007
8	Business Ethics", Hartman L.P. and Chatterjee A., 3rd Edition, Pubs: Tata McGraw Hill.	2006
9	Positive Human Qualities (web)	https://positivepsychology.com/
10	Theory of Moral Development (web)	https://www.verywellmind.com/kohlbergs-theory-of-moral-development-2795071

Semester III

Semester III

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	ES1701	Artificial Intelligence and Machine Learning*	2	0	2	3	ESC-VII
2.	CS1301	Data Structures	3	0	2	4	DCC-I
3.	CS1302	Computer Architecture & Organization	3	0	2	4	DCC-II
4.	CS1303	Discrete Structures for Computer Science	3	1	0	4	DCC-III
5.	CS6301/ CS5301	#Open Elective – I (OE-I)/ Minor Specialization Course (MSC)	3	0	2	4	OE-I/MSC
6.	CS7301	Industrial Tour				2	NAC
					Total Credits	21	

*Common to all branches

Open Elective course will not be offered to B.Tech. (CSE) students

Open Elective – I (OE-I) / Minor Specialization Course (MSC)

Sr. No.	Course Code OE/MSC	Course Name	L	T	P	Credits	Category
1.	CS6301/CS5301	Data Structures*	3	0	2	4	OE-I/MSC

*Open Elective course (Data Structures) will not be offered to B.Tech. (CSE) students

Course Name	**:**	**ARTIFICIAL INTELLIGENCE & MACHINE LEARNING**
Course Code	**:**	**ES1701 (Common to all branches)**
Credits	**:**	**3**
L T P	**:**	**2 0 2**
Type of Course	**:**	**Engineering Science Course (ESC) ESC-VII**

Course Objective:
• Students should learn the basic concepts and techniques of Artificial Intelligence. • Students should be able to develop AI algorithms for solving practical problems.

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION:** Artificial Intelligence and its applications, criteria of success, Intelligent Agents, Nature of Agents, Learning Agents, AI Techniques, Importance, functions, advantages, and limitations of AI	6
2	**PROBLEM SOLVING TECHNIQUES:** State space search, control strategies, heuristic search, problem characteristics, production system characteristics., Generate and test, Hill climbing, Best first search, A* search, Constraint satisfaction problem, Mean-end analysis, Min-Max Search, Alpha-Beta Pruning, Additional refinements, Iterative Deepening	8
3	**KNOWLEDGE REPRESENTATION SCHEMES and LOGIC:** Mapping between facts and representations, Approaches to knowledge representation, Propositional logic, predicate logic, Resolution, Resolution in proportional logic and predicate logic, Clause form, unification algorithm	7
4	**NATURAL LANGUAGE PROCESSING AND EXPERT SYSTEM:** Basic Tasks of Natural Language processing, Expert systems, Expert system examples, Expert System Architectures, Rule base Expert systems, Non Monotonic Expert Systems, Decision tree base Expert Systems.	7
5	**PLANNING:** The Planning problem, planning with state space search, partial order planning, planning graphs, planning with propositional logic, Analysis of planning approaches, Hierarchical planning, conditional planning, Continuous and Multi Agent planning	7
6	**Learning:** Introduction to Learning, Supervised learning, unsupervised learning, Reinforcement learning, Applications of learning	7

Total no. of turns: 14

List of Experiments:		**Number of turns**
1	Implement various problem solving techniques	3
2	Implement knowledge representation techniques	3
3	Implement propositional and predicate logic	2

4	Implement various expert systems	3
5	Implement various learning techniques	3

Course Outcomes: At the end of the course, students will be able to:	
1	Develop an understanding of where and how AI can be used.
2	Design, implement and apply basic AI techniques.

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Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of publication**
1	S. RUSSEL, P. NORVIG, Artificial Intelligence: A Modern Approach, Pearson, 3rd Edition.	2015
2	E. RICH, K. KNIGHT, S. B. NAIR, Artificial Intelligence, McGraw Hill Education, 3rd Edition	2017
3	R.S. SUTTON, A.G. BARTO, Reinforcement Learning: An Introduction, The MIT Press, 2nd Edition	2015

Course Name	**:**	**Data Structures**
Course Code	**:**	**CS1301**
Credits	**:**	**4**
LTP	**:**	**3 0 2**
Type of Course	**:**	**Departmental Core Course (DCC-I)**

Course Objectives:
• The students should be able to describe and implement various data structures.
• They should be able to analyse various algorithms for time and space complexity.
• They should be able to develop algorithms for computational problems and understand the effect of choice of data structures on complexity of algorithm.

Total No. of Lectures- 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION** Introduction to Data Structures, Fundamentals of Algorithms, Time and space complexity of algorithms, Asymptotic Notations, Recursive Algorithms, Recurrence relations.	**5**
2	**ELEMENTARY DATA STRUCTURES** Stacks, queues, Infix, Postfix & Prefix conversions, evaluations of expressions, multiple stacks and queues, priority queues as heaps, double ended queue, implementation of stacks and queues.	**7**
3	**LINKED LISTS** Singly linked lists, linked stacks and queues, doubly linked lists and dynamic storage management, circular linked list, Applications of Stacks, Queues and Linked lists.	**6**
4	**TREES** Basic terminology, binary trees, binary tree traversal, Threaded Trees, Binary Search Tree, AVL tree, B-tree.	**7**
5	**GRAPH THEORY** Graph representations, Graph Traversals, Dijkstra's algorithm for shortest path	**5**
6	**Searching & Sorting** **Brute Force :** Linear search, Insertion sort, selection sort, bubble sort, **Divide & Conquer**: Binary search, quick sort, merge sort **Hash search**	**6**
7	**Greedy Approach**: Prim's and Kruskal's Algorithm for Minimal Spanning tree	2
8	**Introduction to Dynamic Programming & Backtracking**	4

List of Experiments		Number of Turns
1	Implement stack and its various applications.	**1**
2	Implement queue and its various applications.	**1**
3	Implement linked list and its various applications.	**2**
4	Implement binary trees and its various applications.	**2**
5	Implement AVL tree and B tree.	**2**
6	Implement binary search tree and its various applications.	**1**
7	Implement graphs.	**1**
8	Implement minimum spanning tree algorithm.	**2**
9	Implement various searching and sorting algorithms	**2**

Course Outcomes: At the end of the course, students will be able to:	
1.	Demonstrate the ability to select the best data structure to model information in a problem
2	Demonstrate the ability to compare algorithms with respect to time and space complexity.
3	Use efficient data structure and develop algorithm to solve various computational problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Fundamentals of Data Structures, By Ellis Horowitz and Sartaj Sahni, Computer Science Press.	2011
2	An introduction to data structures with applications, By J.P. Trembley & P.G. Sorensen, TMH.	2004
3	Fundamentals of algorithms, Horowitz E, Sahini S, Rajasekaran S., University Press	2008
4	Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein, 3rd edition PHI	2009
5	Data Structures and Program Design in C By Robert L. Kruse,C.L. Tondo, Bruce Leung, Pearson Education.	2007
6	Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser	2013

Course Name	**:**	**COMPUTER ARCHITECTURE AND ORGANIZATION**
Course Code	**:**	**CS1302**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Departmental Core Course (DCC-II)**

Course Objective:

- Students should be able to understand basic principles of Computer Systems.
- They should be able to understand various logic design techniques and their applications.
- They should be capable of analyzing the system performance.

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**BASICS** Introduction to computers with block diagrams, Impact of technology. Designing combinational and sequential logic, computers registers and instructions, timing, and control, instructions cycle, memory reference instruction, I-O interruption.	5
2	**COMPUTER ARITHMETIC** Adder and Subtractor circuits, Booth Multiplication Algorithm, Performance bench marks.	7
3	**CONTROL PATH DESIGN** Sequence counter method, Micro programmed controllers address sequencing, symbolic microinstructions	7
4	**CENTRAL PROCESSING UNIT** Registers General register organization, stack organization, instructions formats, address instructions, addressing modes, data transfer and manipulations, program control, RISC instruction set design, three address instructions and arithmetic pipelines with example of floating point adder, instructions pipelines , advanced pipelining using instruction level parallelism.	10
5	**MEMORY ORIGINATION** Memory device characteristics, Random Access Memory, Serial Access Memory, virtual memory, associative memory, cache memory, memory management hardware, hierarchy of various memories.	7
6	**I/O ORGANIZATION** I/O interface asynchronous data transfer, DMA interrupt, I/O processor.	6

List of Experiments		**Number of Turns**
1	Practicals based on computer arithmetic, control design, CPU design, memory organization and I/O organization	14

Course Outcomes: At the end of the course, students will be able to:	
1	Design the organization of the Control unit, Arithmetic and Logical unit, Memory unit and the I/O unit.
2	Learn different computer architectures and hardware.

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of publication**
1	M. Morris Mano, Computer System & Architecture, Prentice Hall of India	2002
2	John L. Hennessy and David A Patterson, Computer Architecture-A quantitative approach, Morgan Kaufmann/ Elsevier, 4th Edition	2007
3	Hayes .J.P, Computer architecture and organization by McGraw-Hill Companies	1998
4	M.Morris and Charles R. Kinre , Logic and computer design Fundamental, PHI	1995

Course Name	**:**	**DISCRETE STRUCTURES FOR COMPUTER SCIENCE**
Course Code	**:**	**CS1303**
Credits	**:**	**4**
L T P	**:**	**3 1 0**
Type of Course	**:**	**Department Core Course (DCC-III)**

Course Objectives:

- To develop logical thinking and its application to computer science.
- To reason mathematically about basic data types and structures (such as numbers, sets, graphs, and trees) used in computer algorithms and systems; synthesize elementary proofs, especially proofs by induction.
- To model and analyze computational processes using analytic and combinatorial methods.
- To apply principles of discrete probability to calculate probabilities and expectations of simple random processes.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**MATHEMATICAL REASONING** Mathematical reasoning, Propositions, Negation, disjunction and conjunction, Implication and Equivalence, Truth tables, Predicates, Quantifiers, Natural deduction, Rules of Inference, Methods of proofs, Resolution principle, Application to PROLOG.	**7**
2	**SET THEORY** Paradoxes in set theory, Inductive definition of sets and proof by induction, Peano postulates, Relations, Properties of relations, Equivalence Relations and partitions, Partial orderings, POSETs, Linear and well-ordered sets.	**8**
3	**FUNCTIONS** Functions; mappings, Injection and Surjections, Composition of functions, Inverse functions, Special functions, Recursive function theory.	**6**
4	**COMBINATORICS** Elementary combinatorics, Pigeonhole principle, Permutations and Combinations, Counting techniques, Recurrence relations, Solving Linear Recurrence relations, Generating functions.	**9**
5	**GRAPH THEORY** Elements of graph theory, Graph Isomorphism, Euler graph, Hamiltonian path, trees, Tree traversals, Spanning trees, Representation of relations by graphs.	**5**
6	**GROUPS, RINGS, FIELDS** Definition and elementary properties of groups, Semigroups, Monoids, Rings, Fields, Vector spaces and lattices.	**2**

7	**DISCRETE PROBABILITY** Introduction, Probability Theory, Bayes' Theorem, Expected Value and Variance, Discrete random variables.	**5**

List of Experiments: (Use Python Programming language)		**Number of Turns**
1	Print truth table of a compound statement. Example: $[(p \wedge q) \wedge r] \rightarrow (s \vee t)$	1
2	Determine whether a compound statement is valid or not.	1
3	List subsets of set {1, 2, 3, …, n} where $1 \leq n \leq 10$.	1
4	Perform various set operations on a given set such as Union, intersection, difference etc.	
5	List all selections of size 2 from the objects 1, 2, 3, 4, 5, 6. Mention scenarios such as repetition allowed or not etc. Repeat the same for selections of size 3.	1
6	List the integer solutions of a constrained linear equation. Example: $x_1 + x_2 + x_3 = 10,\ 0 \leq x_i,\ 1 \leq i \leq 3$	1
7	Write a recursive function to compute gcd of two numbers.	1
8	Based on given data, determine various properties of a relation.	
9	Implement Spanning trees.	1
10	Implement Tree traversal techniques.	1
11	Determine whether a graph is Euler graph or not.	2
12	Solve Tower of Hanoi problem.	2
13	Create Sudoku Solver.	2

Course Outcomes: At the end of the course, students will be able to:	
1	Use logical notation to define and reason about fundamental mathematical concepts such as sets, relations, functions, and integers. Analyze logical propositions via truth tables.
2	Synthesize induction hypotheses and simple induction proofs.
3	Calculate numbers of possible outcomes of elementary combinatorial processes such as permutations and combinations.
4	Apply graph theory models of data structures and state machines to solve problems of connectivity and constraint satisfaction, for example, scheduling.
5	Prove elementary properties of modular arithmetic and explain their applications in Computer Science, for example, in cryptography and hashing algorithms.
6	Calculate probabilities and discrete distributions for simple combinatorial processes; calculate expectations.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**

1	K. H. Rosen, Discrete Mathematics and applications, 7th Edition, McGraw Hill	2012
2	Seymour Lipschutz and Marc Lipson, Schaum's Outline of Discrete Mathematics, 3rd Edition	2010
3	J. L. Mott, A. Kandel, T. P. Baker, Discrete Mathematics for Computer Scientists and Mathematicians, 2nd Edition, Pearson India	2015
4	C. L. Liu and D. P. Mohapatra, Elements of Discrete Mathematics, 4th Edition., McGraw-Hill	2012
5	C. Stein, R. L. Drysdale, K. Bogart, Discrete Mathematics for Computer Scientists, Second edition, Pearson Education Inc.	2011
6	W. K. Grassmann and J. P. Trembnlay, Logic and Discrete Mathematics, A Computer Science Perspective, Prentice Hall Inc	2007
7	M. Litvin and G. Litvin, Coding in Python and Elements of Discrete mathematics, Skylight Publishing	2019
8	A. M. Stavely, Programming and Mathematical Thinking, The New Mexico Tech Press	2014

Course Name	**:**	**Data Structures**
Course Code	**:**	**CS6301/CS5301 (OE-I/MSC)**
Credits	**:**	**4**
LTP	**:**	**3 0 2**
Type of Course	**:**	**Open Elective – I (OE-I) Minor Specialization Course (MSC)**

Course Objectives:
• The students should be able to describe and implement various data structures.
• They should be able to analyse various algorithms for time and space complexity.
• They should be able to develop algorithms for computational problems and understand the effect of choice of data structures on complexity of algorithm.

Total No. of Lectures- 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION** Introduction to Data Structures, Fundamentals of Algorithms, Time and space complexity of algorithms, Asymptotic Notations, Recursive Algorithms, Recurrence relations.	**5**
2	**ELEMENTARY DATA STRUCTURES** Stacks, queues, Infix, Postfix & Prefix conversions, evaluations of expressions, multiple stacks and queues, priority queues as heaps, double ended queue, implementation of stacks and queues.	**7**
3	**LINKED LISTS** Singly linked lists, linked stacks and queues, doubly linked lists and dynamic storage management, circular linked list, Applications of Stacks, Queues and Linked lists.	**6**
4	**TREES** Basic terminology, binary trees, binary tree traversal, Threaded Trees, Binary Search Tree, AVL tree, B-tree.	**7**
5	**GRAPH THEORY** Graph representations, Graph Traversals, Dijkstra's algorithm for shortest path	**5**
6	**Searching & Sorting** **Brute Force :** Linear search, Insertion sort, selection sort, bubble sort, **Divide & Conquer**: Binary search, quick sort, merge sort **Hash search**	**6**
7	**Greedy Approach**: Prim's and Kruskal's Algorithm for Minimal Spanning tree	2
8	**Introduction to Dynamic Programming & Backtracking**	4

List of Experiments		Number of Turns
1	Implement stack and its various applications.	**1**
2	Implement queue and its various applications.	**1**
3	Implement linked list and its various applications.	**2**
4	Implement binary trees and its various applications.	**2**
5	Implement AVL tree and B tree.	**2**
6	Implement binary search tree and its various applications.	**1**
7	Implement graphs.	**1**
8	Implement minimum spanning tree algorithm.	**2**
9	Implement various searching and sorting algorithms	**2**

Course Outcomes: At the end of the course, students will be able to:	
1.	Demonstrate the ability to select the best data structure to model information in a problem
2	Demonstrate the ability to compare algorithms with respect to time and space complexity.
3	Use efficient data structure and develop algorithm to solve various computational problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Fundamentals of Data Structures, By Ellis Horowitz and Sartaj Sahni, Computer Science Press.	2011
2	An introduction to data structures with applications, By J.P. Trembley & P.G. Sorensen, TMH.	2004
3	Fundamentals of algorithms, Horowitz E, Sahini S, Rajasekaran S., University Press	2008
4	Introduction to Algorithms, Cormen, Leiserson, Rivest, Stein, 3rd edition PHI	2009
5	Data Structures and Program Design in C By Robert L. Kruse,C.L. Tondo, Bruce Leung, Pearson Education.	2007
6	Data Structures and Algorithms in Python, Michael T. Goodrich, Roberto Tamassia, Michael H. Goldwasser	2013

Semester IV

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	HS2301 / HS2302 / HS2303 / HS2304	Basics of Economics / French- Basic / General Psychology / Sociology	2 2 2 2	1 1 1 1	0 0 0 0	3	HSM-II
2.	CS1401	Analysis & Design of Algorithms	3	0	2	4	DCC-IV
3.	CS1402	Operating Systems	3	0	2	4	DCC-V
4.	CS1403	Computer Networks	3	0	2	4	DCC-VI
5.	CS6401/ CS5401	*Open Elective –II (OE-II) / Minor Specialization Course (MSC)	3	0	2	4	OE-II/MSC
6.	PC7401	Proficiency-I				2	Proficiency
Total Credits						21	
Department Honours Course – 1 (DHC-1)							
7.	CS3401	Database Systems	3	0	2	4	DHC-I
Total Credits (Including Honours)						25	

* Open Elective course will not be offered to B.Tech. (CSE) students

Open Elective – II (OE-II) / Minor Specialization Course (MSC)

Sr. No.	Course Code OE-II/MSC	Course Name	L	T	P	Credits	Category
1.	CS6401/ CS5401	Analysis and Design of Algorithms*	3	0	2	4	OE-II/MSC

* Open Elective course (Analysis and Design of Algorithms) will not be offered to B.Tech. (CSE) students

Course Name	**:**	**Basics of Economics**
Course Code	**:**	**HS2301**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
• To make students understand how society manages its scarce resources for achieving maximum satisfaction. • To discuss the economic aspects related to a consumer, firm, market and economy.

Total No. of Lectures – 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Economics** Why study Economics? Scope of Economics; Types of Economics; Concepts of Economics: Wealth, Welfare and Scarcity; Economic Problem: Scarcity and Choice; Concept of Opportunity Cost; The Question of What to Produce, How to produce and for Whom to Produce; Economic Activities: Consumption, Production, Exchange, Distribution and Public Finance; Relationship of Economics with other Social Sciences and Engineering	**(4)**
2	**Theory of Consumer Behaviour** Demand-Types of Demand; Determinants of Demand; Change in Demand: Movement and Shift of Demand; How to Estimate Demand? Law of Demand, Elasticity of Demandand its Application in Present Scenario. Utility Analysis; Assumptions; Consumption Decision: BudgetConstraint; Changes in ConsumptionPattern; Laws of Consumption: Concept and Applicability of Law of Diminishing Marginal Utility and Law of Equi-Marginal Utility.	**(6)**
3	**Cost and Production Analysis** Cost Concept; Production and Cost; Cost in the Short and Long Run; Short-Run Cost and Output Decision; Cost and Output in the Long Run. Relationship between TC, AC and MC. Production: Scale of Production, Short Run Production Function; Long Run Production Function; Stages, Significance and Practical Application ofLaw of Variable Proportion and Law of Return to scale. Economiesand Diseconomies of Scale: Concept and Types. Relevance of Production and Cost Concept in Real Situation.	**(6)**
4	**Market Structure**	**(3)**

	Perfect Competition, Monopoly, Oligopoly and Monopolistic Competition; Comparison Between Different Forms of Market Structure with Real Life Examples; Government Policies towards Different Forms;Nature and Relevance of different Markets in Present Scenario.	
5	**Basic Macro Economics Concepts** Importance of studying Macroeconomics; Interest Rates Determination; Sources of Interest Rate Differentials; Unemployment and Full Employment; Profit Concept: Functions of Profit; Economic Profit and Accounting Profit.	**(3)**
6	**National Income and Inflation** National Income Concepts; GDP, GNP, NNP; Measurement of National Income: Income, Expenditure and Value Added Methods; Types of Inflation; Role of Inflation in Economic Development.	**(3)**
7	**Economic Policies** Monetary and Fiscal Policy; Instruments ofMonetary and Fiscal Policy; Role of Monetary and Fiscal Policy in a Developing Country; Money: Functions; Determination of Money supply.	**(3)**

Total No. of Tutorials-14

Hour wise Breakup		**No. of Tutorials**
	Tutorials based on Lectures	14

Course Outcomes:	
1	The students are expected to apply engineering knowledge to maximize profit, satisfaction and welfare.
2	The students are able to identify the forces that affect the economy.

Suggested Books:		
S.No.	***Name of Book/ Authors/ Publisher***	***Year of Publication/ Reprint***
	Text Books	
1	"Principles of Microeconomics",Stiglitz J.E. and Walsh C.E.,W.W. Norton & Company.	2016
2	"Principles of Macroeconomics",Stiglitz J.E. and Walsh C.E., Pubs: W.W. Norton & Company.	2016
	Reference Books	
1	"Managerial Economics: Foundations of Business Analysis and Strategy", Thomas and Mauris, McGraw Hill.	2017

2	"Principles of Economics", Greenlaw S.A., Shapiro D., Taylor T., Pubs: OpenStax	2017

Suggested E-Material:		
S.No.	***Title/Name of Authors/(Type of material)***	***Retrieval Source***
1	"Managerial Economics", Mishra Trupti. (video)	www.nptel.ac.in/courses/110101005/
2	"Macro Economics", SinhaSurajit. (video)	www.nptel.ac.in/courses/109104073/
3	"Business Analysis for Engineers", Vaidhyasubramaniam S. (video)	www.nptel.ac.in/courses/110106050/

Evaluation Scheme		
S.No.	***Category***	***Marks***
1	Mid Term	20
2	Assignments/Quizzes/Case Study	20
3	Project Report and Presentation	20
4	End Term	40

Course Name	**:**	**French- Basic**
Course Code	**:**	**HS2302**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
The main aim of this course is to introduce students with basics of a foreign language and make them learn how to communicate in a new language.

Total No. of Lectures – 28

Lecture wise breakup		**No. of Lectures**
1	Greetings/Politeness – Formal/Informal	**(2)**
2	Alphabet / Full name + maiden name / Verbs	**(2)**
3	Question-answer/subject pronouns	**(2)**
4	Questions - what / words	**(2)**
5	Asking and answering basic questions: age/date of birth/numbers and calendar/ verb	**(2)**
6	Locating a place / giving information about one's region, city or country/Phone number/email/signs and punctuations/ Verb	**(2)**
7	Nationality/masculine/feminine	**(2)**
8	Prepositions/Countries/cities/Articles	**(2)**
9	Negative pronouns/tonic pronouns	**(2)**
10	Family members/possessive articles	**(2)**
11	Profession/work place/masculine/feminine	**(2)**
12	Like/dislike	**(2)**
13	Activities (sports/culture/instruments)	**(2)**
14	Verb/prepositions	**(2)**

Tutorials **Total No. of Tutorials – 14**

	Revision/exercise based on the lecture class.	**14**

Course Outcomes:	
1	The students will be able to express themselves in the foreign language.
2	The students will be able to make use of this language in their professional life in the globalized world.

Suggested Books:		
S.No.	***Name of Book/ Authors/ Publisher***	***Year of Publication/ Reprint***
	Text Books	
1	Saison 1, DelphineRebaud et al: Didier	2015
2	"Complete French", Graham G., Pubs: Hodder& Stoughton.	2012
	Reference Books	
1	"French Made Easy", Verma R., 1st Edition, Pubs: Goodwill Publishing House, New Delhi.	2012

2	"French Made Easy", Khan F., Pubs: Lotus Press.	2010

Evaluation Criteria

Assignments/ Quizzes: 30 marks

Mid Term: 20 marks

End term: 50 marks

Total: 100 marks

Course Name	**:**	**General Psychology**
Course Code	**:**	**HS2303**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
The main aim of the course is to provide knowledge and understanding about important concepts in Psychology which will help the students in learning the applications of principles of psychology in personal and professional life.

Total No. of Lectures – 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Psychology** Concept, Nature and Scope Methods of Studying Human Behaviour – Introspection Method, Observation Method, Experimental Method, Case History Method, Survey Method.	**(4)**
2	**Intelligence** Concept and Determinants of Intelligence Theories of Intelligence and its Application: Spearman, Thurston, Guilford.	**(4)**
3	**Personality** Personality: Concept, Determinants of Personality, Trait Paradigm (Eysenck), Psychodynamic Paradigm (Freud), Measurement of Personality – Self Report Measures (EPQ), Projective Measures (TAT).	**(4)**
4	**Mental Health and Stress** Mental Health: Concept and Factors Affecting Mental Health Stress: Nature, Rections to Stress, Outcomes of Stress, Stress Management	**(4)**
5	**Learning and Memory** Learning: Concept, Reinforcement Principle and Learning, Managerial Implications Memory: Concept, Long Term Memory, Short Term Memory, Episodic Memory, Methods to Improve Memory	**(3)**
6	**Motivation** Nature and Types of Motivation: Extrinsic and Intrinsic Theories of Motivation and its Application: Humanistic and Need Theories	**(3)**
7	**Group Behaviour and Dynamics** Concept and Importance, Types of Groups, Group Development, Group Performance Factors , Conflict: Nature, Conflict Resolution, Case Study	**(4)**
8	**Leadership** Leadership: Nature and Importance, Leadership Styles: Authoritarian, Democratic, Paternalistic, Laissez faire, Transactional, Transformational	**(2)**

Total No. of Tutorials – 14

	Revision/discussions based on the lecture class	**14**

Course Outcomes:	
1	The students will learn the causes and dynamics of human behavior.
2	The students will be able to apply psychological principles to enhance their personal and professional life.

Suggested Books:		
S.No.	***Name of Book/ Authors/ Publisher***	***Year of Publication/ Reprint***
	Text Books	
1	"Psychology", Ciccarelli S.K. and Meyer G.E., Pubs: Pearson India.	2007
2	"Introduction to Psychology", Morgan C.T., Weiss J.R., King R.A. and Schopler J., 7th Edition, Pubs: McGraw-Hill Education.	2004
	Reference Books	
1	"Fundamentals of Social Psychology", Baron R.A., Branscombe N.R., Byrne D. and Bhardwaj G., 1st Edition, Pubs: Pearson India.	2011
2	Organizational Behavior", Luthans F., Pubs: McGraw Hill Education.	2010

EVALUATION CRITERIA:

Assignments/ Quizzes/ Case Study/ Project/ PPT: 40 marks

Mid Term: 20 marks

End term: 40 marks

Total: 100 marks

Course Name	**:**	**Sociology**
Course Code	**:**	**HS2304**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
The main aim of the course is to make the students understand the role of theory in social sciences and to explain them how social problems interact and react with the larger society. This course also intends to make them learn whether the problem is evaluated on the macro or micro perspective and their cause and effect patterns.

Total No. of Lectures – 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Sociology** Sociology as a Science, Impact of Industrial and French Revolution on the Emergence of Sociology, Contribution of Karl Marx, Emile Durkheim, Max Weber, AlwinToeffler to Sociology and its Application in present scenario, Relevance of Sociology for Engineering	**(5)**
2	**Basic Concepts** Society, Association, Institution, Culture Relativism, Social Structure, Social System, Socialization, Competition, Conflict, Accommodation, Social Mobility	**(2)**
3	**Society and Economy** Evolution of Society: Primitive, Agrarian, Industrial and Post-Industrial, Economic Systems of Simple and Complex Societies, Sociological Dimensions of Economic Life, Market (free) Economy and Controlled (planned) Economy	**(4)**
4	**Industrial Sociology** Nature and Scope of Industrial Sociology, Pre-Conditions and Consequences of Industrialization, Impact of Automation and Industrialization on Society with Case Study	**(3)**
5	**Science and Technology** Ethos of Science and Social Responsibility of Science	**(2)**
6	**Social Change** Theories of Change and its Application to Sociology, Factors Role of Engineers in Development	**(4)**
7	**Indian Society** Traditional Hindu Social Organization, Caste System, Green Revolution, Working of the Democratic Political System in a Traditional Society, Problem of Education in India, Gender Discrimination, Economic Reforms: Liberalization, Privatization and Globalization, Strategies for Development in India, Case Studies	**(6)**

8	**Social Problems** Concept of AIDS, Alcoholism, Drug Addiction, Corruption with Case Study	**(2)**

Tutorials- 14

Hour wise breakup		**No. of Hours: 14**
	Practical Work based on Lectures	

Course Outcomes:	
1	The students will be able to identify the function and application of sociology theory in social sciences.
2	The students will be able to understand how social class affects individual life chances.
3	The students will learn about social structure and how it shapes and influences social interactions.

Suggested Books:		
S. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
	Text Books	
1	"Sociology: Themes and Perspective",Haralambos M. and HolbornM.,Pubs: Collins Educational Publications.	2008
2	"An Introduction to Sociology",Dassgupta S. and SahaP., Pubs: Dorling Kindersley (India) Pvt. Ltd.	2012
	Reference Books	
1	"Industrial Sociology",Singh N., 1st Edition, Pubs: McGraw Hill Education (India).	2012
2	"Society in India: Concepts, Theories and Recent Trends", Ahuja R., 1st Edition,Pubs: Rawat Publications.	2011

Evaluation Criteria

Assignments/ Quizzes/ Case Study/ Project/ PPT: 40 marks

Mid Term: 20 marks

End term: 40 marks

Total: 100 marks

Course Name	**:**	**ANALYSIS & DESIGN OF ALGORITHMS**
Course Code	**:**	**CS1401**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Core course (DCC-IV)**

Course Objectives:
The students should be able to analyze various algorithms mainly for time and space complexity. They should be able to develop algorithm for solving various computational problems by applying various algorithm design strategies. They should be able to understand the affect of choice of data structures on the complexity of algorithm.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASIC CONCEPTS OF ALGORITHMS** Introduction – Notion of Algorithm – Fundamentals of Algorithmic Solving – Important problem types – Fundamentals of the Analysis Framework – Asymptotic Notations and Basic Efficiency Classes.	**6**
2	**MATHEMATICAL ASPECTS AND ANALYSIS OF ALGORITHMS** **Mathematical analysis of non-recursive algorithms. Mathematical analysis of recursive algorithm: recurrence relations, solution of recurrence relations using substitution method.**	**5**
3	**BRUTE FORCE** **Selection sort, Bubble sort, Sequential searching (Linear Search), Brute force string matching.**	**4**
4	**DIVIDE AND CONQUER STRATEGY** **General method, Merge sort, Quick Sort, Binary Search, Strassen's matrix multiplication**	**4**
5	**GREEDY APPROACH** **General method, Fractional Knapsack problem, Minimum cost spanning tree: Prim's and Kruskal's algorithm, Single source shortest path problem**	**5**
6	**DYNAMIC PROGRAMMING** **General method, Principle of optimality, Multi-stage graph problem, All pair shortest path problem, 0/1 Knapsack problem, Traveling salesperson problem.**	**6**
7	**BACKTRACKING** **General method, N-Queen problem, 0/1 Knapsack problem**	**4**
8	**BRANCH AND BOUND** **General method, 0/1 Knapsack problem, Traveling sales person problem**	**4**
9	**LOWER BOUND THEORY AND COMPELXITY CLASSES** **Lower bounds, Decision trees, P, NP and NP Complete problems**	**4**

Course Outcomes: At the end of the course, students will be able to:	
1	Demonstrate the ability to select the best data structure for designing an algorithm to solve a given problem.
2	Demonstrate the ability to compare algorithms with respect to time and space complexity.
3	Develop algorithms to solve various computational problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Algorithm Design, Jon Kelinberg and Eva Tardos, 1st Edition, Pearson Education	2014
2	Fundamentals of algorithms, Horowitz E, Sahini S, Rajasekaran S., University Press	2008
3	Introduction to algorithms, Cormen, Leiserson, Rivest, Stein, 3rd Edition, PHI.	2012
4	An introduction to analysis of algorithms, R. Sedgewick, 1st edition, Pearson Education	1996
5	Data Structures and Program Design in C By Robert L. Kruse, C.L. Tondo, Bruce Leung, Pearson Education.	2007

Course Name	**:**	**Operating Systems**
Course Code	**:**	**CS1402**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Departmental Core Course (DCC-V)**

Course Objectives:
Students should be able to describe the purpose, structure and functions of operating system. They should be able to understand the file system, processes synchronization, process scheduling, system calls and memory management techniques used in an operating system.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CONCEPTS OF OPERATING SYSTEMS** Computer system overview, concept of an operating system, multiprogramming, multiprocessing, multi user, time sharing, Multitasking, personal system, parallel system, real time system, general system architecture, System components, operating system services, system calls, system programs, system structure, Approaches to OS design and implementation	**8**
2	**PROCESSES MANAGEMENT** Concept of process, process states, process state transitions, process control block, operations on processes, Process scheduling , scheduling criteria	**3**
3	**PROCESS SYNCHRONIZATION** Concurrent programming and Deadlocks Critical regions, Conditional critical regions, Monitors, Inter process communication, Messages, Pipes, Semaphores, Modularization, Synchronization, Concurrent languages. Deadlocks: Characterization, Prevention, Avoidance, Detection and Recovery, Combined approach to Deadlock Handling, precedence graphs.	**5**
4	**MEMORY MANAGEMENT** Logical and physical address space, storage allocation and management techniques, swapping concepts of multi programming, paging, segmentation, virtual Memory, demand paging, page replacement algorithm, thrashing	**8**
5	**INPUT/OUTPUT AND DATA MANAGEMENT** File organization, record blocking, access method, directory structure, protection file system structure, allocation methods, free space management, directory implementation, disk structure, disk scheduling, disk management, buffering, swap space management, RAID levels	**8**
6	**NETWORKS OPERATING SYSTEM AND DESIGN PRINCIPLES**	**4**

	Network operating system, distributed operating system, external security, operational security, password protection, access control, security kernels, hardware security, layered approach, design principle.	
7	**OS SECURITY THREATS** Types of Threats in Operating System, Understanding the Threats: Malware, Viruses, Worms, Rootkits, Defense -- An Overview, Logging, Auditing, and Recovery	**3**
8	**CASE STUDIES** Linux/Unix OS design and architecture, Unix shell, Unix operating system services, user perspective, representation of files in Unix system processes and their structure, input-output system, memory management in Unix	**3**

List of Experiments:		**Number of Turns**
1	To perform shell programming	4
2	Implementation of memory management techniques like paging or segmentation	2
3	Implementation of Process scheduling techniques	2
4	Use the system calls of UNIX/Linux operating system: mkdir, rmdir, link, unlink, mount, chown, chmod, getuid, setuid, fork, wait, exec, exit, kill, getpid, brk, nice, sleep, trace, open, close, read, write, lseek, stat, sync	3
5	Use the following system calls of UNIX operating system: signals, pipe, socket, accept, snd, recv, connect	1

Course Outcomes:	
1	Understanding of design issues associated with operating systems
2	Write and/or modify concurrent programs.
3	Master various process management concepts including scheduling, synchronization, and deadlocks.
4	Apply security as well as recovery feature in the design of algorithms.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Operating system, Galvin & Silberschatz, 9th Edition, John Willey	Latest edition
2	Operating Systems-A Concept Based Approach By Dhamdhare, TMH	Latest edition

3	Operating systems Internals and design principles By William Stallings, Pearson Education	Latest edition
4	Operating Systems –A Design Oriented approach By Crowley, TMH	Latest edition
5	Operating systems Design and Implementation By Andrew S. Tanenbaum, Pearson Education	Latest edition

Course Name	**:**	**Computer Networks**
Course Code	**:**	**CS1403**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Departmental Core Course (DCC-VI)**

Course Objectives:

- Students should be able to have an understanding of the fundamental concepts of computer networking and have a basic knowledge of the various network models and their uses.
- They should be able to understand the organization of computer networks, factors influencing computer network development and the reasons for having variety of different types of networks.
- They should be able to analyze simple protocols and independently study literature concerning computer networks.

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1.	**COMPUTER NETWORKS AND THE INTERNET** What is the Internet; network edge; network core; Delay, Loss and throughput in Packet-Switched Networks; Protocol Layers and their Service Models.	6
2.	**APPLICATION LAYER** Principles of Network Applications; The Web and HTTP; File Transfer: FTP;Electronic Mail in the Internet; DNS - The Internet's Directory Service	8
3.	**TRANSPORT LAYER** Introduction and Transport-Layer Services; Multiplexing and Demultiplexing; Connectionless Transport: UDP; Connection-Oriented Transport: TCP; TCP Congestion Control.	10
4.	**NETWORK LAYER** Introduction; Virtual circuit and datagram networks; What is inside a router; Internet Protocol (IP): Forwarding and Addressing in the Internet; Routing Algorithms; Routing in the Internet	10
5.	**DATA LINK LAYER** Introduction to the link layer; Error Detection and Correction Techniques; Multiple Access links and Protocols; Switched local area networks.	8

List of experiments:		**No. of Turns**
1.	Understanding and using of commands like ping, ipconfig, hostname, getmac, arp, nslookup, netstat, tracert, route,pathping	2

2.	Socket Programming – Installing and learning Linux operating system, Understanding the syntax, purpose and use of various functions used in sockets 74rogramming – connect(), send(), recv(), bind(), listen(), accept(), sendto(), recvfrom() etc. functions, TCP/IP based echo client server and UDP/IP based echo client server	3
3.	Practicals based on Wireshark – getting started, HTTP, DNS, TCP, IP, ICMP, Ethernet & ARP, DHCP etc.	9

Course Outcomes:	
At the end of the course, students will be able to:	
1.	Independently understand basic computer network technology.
2.	Understand and explain various components of computer networks.
3.	Identify the different types of network topologies and protocols.
4.	Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.
5.	Identify the different types of network devices and their functions within a network.
6.	Understand and build the skills of routing mechanisms.
7.	Familiarize with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Suggested Books:		
Sr. No.	**Name of books / Author/ Publisher**	**Year of Publication/ Reprint**
1.	James F. Kurose and Keith W. Ross, “Computer Networking: A top down approach”, Pearson Education, 6th edition.	2017
2.	A.S. Tanenbaum, “Computer Networks”, 5th Edition, PHI	2010
3.	G. Keiser, “Local Area Networks”, 2nd Edition, TMH	2002
4.	D. Bertesekas and R. Gallager, “Data Networks”, 2nd Edition, PHI	2010

Course Name	**:**	**ANALYSIS & DESIGN OF ALGORITHMS**
Course Code	**:**	**CS6401/CS5401 (OE-II/MSC)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Open Elective – II (OE-II) Minor Specialization Course (MSC)**

Course Objectives:
The students should be able to analyze various algorithms mainly for time and space complexity. They should be able to develop algorithm for solving various computational problems by applying various algorithm design strategies. They should be able to understand the affect of choice of data structures on the complexity of algorithm.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASIC CONCEPTS OF ALGORITHMS** Introduction – Notion of Algorithm – Fundamentals of Algorithmic Solving – Important problem types – Fundamentals of the Analysis Framework – Asymptotic Notations and Basic Efficiency Classes.	**6**
2	**MATHEMATICAL ASPECTS AND ANALYSIS OF ALGORITHMS** **Mathematical analysis of non-recursive algorithms. Mathematical analysis of recursive algorithm: recurrence relations, solution of recurrence relations using substitution method.**	**5**
3	**BRUTE FORCE** **Selection sort, Bubble sort, Sequential searching (Linear Search), Brute force string matching.**	**4**
4	**DIVIDE AND CONQUER STRATEGY** **General method, Merge sort, Quick Sort, Binary Search, Strassen's matrix multiplication**	**4**
5	**GREEDY APPROACH** **General method, Fractional Knapsack problem, Minimum cost spanning tree: Prim's and Kruskal's algorithm, Single source shortest path problem**	**5**
6	**DYNAMIC PROGRAMMING** **General method, Principle of optimality, Multi-stage graph problem, All pair shortest path problem, 0/1 Knapsack problem, Traveling salesperson problem.**	**6**
7	**BACKTRACKING** **General method, N-Queen problem, 0/1 Knapsack problem**	**4**
8	**BRANCH AND BOUND** **General method, 0/1 Knapsack problem, Traveling sales person problem**	**4**
9	**LOWER BOUND THEORY AND COMPELXITY CLASSES** **Lower bounds, Decision trees, P, NP and NP Complete problems**	**4**

Course Outcomes: At the end of the course, students will be able to:	
1	Demonstrate the ability to select the best data structure for designing an algorithm to solve a given problem.
2	Demonstrate the ability to compare algorithms with respect to time and space complexity.
3	Develop algorithms to solve various computational problems.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Algorithm Design, Jon Kelinberg and Eva Tardos, 1st Edition, Pearson Education	2014
2	Fundamentals of algorithms, Horowitz E, Sahini S, Rajasekaran S., University Press	2008
3	Introduction to algorithms, Cormen, Leiserson, Rivest, Stein, 3rd Edition, PHI.	2012
4	An introduction to analysis of algorithms, R. Sedgewick, 1st edition, Pearson Education	1996
5	Data Structures and Program Design in C By Robert L. Kruse, C.L. Tondo, Bruce Leung, Pearson Education.	2007

Course Name	**:**	**Database Systems**
Course Code	**:**	**CS3401**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Honours Course – 1 (DHC-1)**

Course Objectives:

- Learn current database design principles and practices.
- Implement database designs as physical and conceptual DBMS models
- Learn how to interpret and construct basic SQL queries and database management commands.

Total No. Lectures: 42

Sr. No.	Course contents	No. of Lectures
1.	**O**verview of database systems, Critical thinking in computer science and database, Database planning and stages. Data modeling: Physical, logical and conceptual data models, the entity-relationship model, extended ER model Conversion of the ER model to relational schema The relational database model: Logical view of data, keys, superkeys and candidate keys, foreign keys, integrity rules.	10
2.	Relational Algebra, Relational Calculus, computational capabilities, Embedded SQL Programming, Web DB development with Python Query Processing, evaluation and optimization, Files, Indexing and Hashing, I/O cost models for indexing, tree-based indexing.	08
3.	SQL: data definition, aggregate function, Null Values, nested sub queries, Joined relations. Triggers, Views, updates on views, comparison between tables and views	06
4.	Introduction to DB design, Normalization theory and normal forms, loss-less join and dependency preservation, normal forms – 1NF, 2NF, 3NF, BCNF, multi-valued dependency and 4NF	06
5.	Transaction management: ACID properties, serializability and concurrency control, Lock based concurrency control (2PL, Deadlocks), Time stamping methods, optimistic methods, database recovery management, , Concurrency control, Atomicity control, Recovery control, Database privacy and security	07
6.	Advanced Database systems, data mining, Big Data, No SQL, New SQL, Modern databases based on these concepts.	05

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1.	For a given scenario of database application, Create the required tables using SQL Commands	2
2.	Write Sql queries to apply the constraints i.e. Primary Key, Foreign key, UNIQUE to the tables by using Null values and different clauses	3

3.	Usage of SELECT, rename, tuple operations, DELETE etc. along with various String operations, Set operations	3
4.	SQL queries for implementing JOINs and types of joins with conditions.	2
5.	SQL nested queries for a particular scenario.	1
6.	SQL queries to create the views ,triggers	1
7.	SQL queries to create indexes and apply on a database.	1
8.	Design and implementation of Project based component	1

Course Outcomes:

At the end of the course, students will be able to:	
1.	Design an usable E-R Model that incorporates database specifications
2.	Convert English statements of database queries to their corresponding SQL expressions
3.	Design database and identify functional dependencies and use them to improve initial design

Bibliography:

Sr. No.	**Book Detail**	**Year of Publication**
1.	"Database System Concepts", Abraham Silberschatz, Henry F. Korth, S. Sudharshan, Tata McGraw Hill,	2006
2.	"Fundamentals of Database Systems", Elmsari and Navathe, Pearson Education	2013
3.	Database Management Systems , Ramakrishnan and Gehrke, McGrawHill	2003

Semester V

Semester V

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS1501	Theory of Computation	3	1	0	4	DCC-VII
2.	CS1502	Soft Computing	3	0	2	4	DCC-VIII
3.	CS1503	Software Engineering	3	0	2	4	DCC-IX
4.	CS1504	Minor Project	0	0	6	3	DCC-X
5.	CS2501 to CS2506	Department Elective Course – I (DEC-I)	3	0	2	4	DEC-I
6.	CS2507 to CS2512	Department Elective Course – II (DEC-II)	3	0	2	4	DEC-II
					Total Credits	23	
Department Honours Course – 2 (DHC-2)							
7.	CS3501	Compiler Design	3	0	2	4	DHC-2
					Total Credits (Including Honours)	27	

Department Elective Course - I (DEC-I)

Sr. No.	Course Code DEC-I/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2501/CS4501	Machine Learning	3	0	2	4	AI& ML
2.	CS2502	Logic and Functional Programming	3	0	2	4	AI& ML
3.	CS2503	Introduction to Internet of Things	3	0	2	4	NSS
4.	CS2504/CS4502	Wireless & Mobile Networks	3	0	2	4	NSS
5.	CS2505/CS4503	Introduction to Information Science	3	0	2	4	CIS
6.	CS2506	Microprocessor and its Applications	3	0	2	4	CIS

Department Elective Course - II (DEC-II)

Sr. No.	Course Code	Course Name	L	T	P	Credits	Specialization domain
1.	CS2507	Concepts in Statistical Learning Theory	3	0	2	4	AI& ML
2.	CS2508	Natural Language Processing	3	0	2	4	AI& ML
3.	CS2509	Applied Cryptography	3	0	2	4	NSS
4.	CS2510	High Speed Networks	3	0	2	4	NSS
5.	CS2511	Web Information Retrieval and Crawling	3	0	2	4	CIS
6.	CS2512	Clean Coding Practices	3	0	2	4	CIS

Course Name	**:**	**THEORY OF COMPUTATION**
Course Code	**:**	**CS1501**
Credits	**:**	**4**
L T P	**:**	**3 1 0**
Type of Course	**:**	**Departmental Core Course (DCC-VII)**

Course Objectives:

Students should be able to understand fundamental mathematical and computational principles that are foundations of computer science. They should learn about abstract models of computation, finite representations for languages and will gain formal understanding of algorithms and procedures.

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**AUTOMATA** Introduction to formal proof, Additional forms of proof, Inductive proofs, Finite Automata (FA), Deterministic Finite Automata (DFA), Non-deterministic Finite Automata (NFA), Finite Automata with Epsilon transitions.	**9**
2	**REGULAR EXPRESSIONS AND LANGUAGES** Regular Expression, FA and Regular Expressions, Proving languages not to be regular, Closure properties of regular languages, Equivalence and minimization of Automata	**9**
3	**CONTEXT-FREE GRAMMARS AND LANGUAGES** Context-Free Grammar (CFG), Parse Trees, Ambiguity in grammars and languages, Definition of the Pushdown automata, Languages of a Pushdown Automata, Equivalence of Pushdown automata and CFG Deterministic Pushdown Automata.	**9**
4	**PROPERTIES OF CONTEXT-FREE LANGUAGES** Normal forms for CFG, Pumping Lemma for CFL, Closure Properties of CFL, Turing Machines, Programming Techniques for TM, Variations of TM, Non-Universal TM, Universal TM.	**8**
5	**UNDECIDABALITY** A language that is not Recursively Enumerable (RE), An undecidable problem that is RE Undecidable problems about Turing Machine, Post's Correspondence Problem, The classes P and NP.	**7**

Course Outcomes: At the end of the course, students will be able to:

1	Express computer science problems as mathematical statements and to formulate proofs.
2	Become proficient in key topics of theory of computation, and to have the opportunity to explore the current topics in this area.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	J.E. Hopcroft, R. Motwani and J.D. Ullman, "Introduction to Automata Theory, Languages and Computations", second Edition, Pearson Education	2007
2	H.R. Lewis and C.H. Papadimitriou, "Elements of the theory of Computation", Second Edition, Pearson Education	2003
3	Thomas A. Sudkamp," An Introduction to the Theory of Computer Science, Languages and Machines", Third Edition, Pearson Education.	2007
4	J. Martin, "Introduction to Languages and the Theory of computation" Third Edition, Tata Mc Graw Hill.	2007

Course Name	**:**	**SOFT COMPUTING**
Course Code	**:**	**CS1502**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Departmental Core Course (DCC-VIII)**

Course Objective:

- Students should be able to understand soft computing concepts and techniques and foster their abilities in designing and implementing soft computing based solutions for real-world problems.

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION TO NEURAL NETWORKS** Structure and working of Biological Neural Network, Fundamentals of Artificial Neural Networks & Applications, Characteristics of Artificial Neural Networks, History of neural network research, characteristics of neural networks terminology	7
2	**NEURAL NETWORKS MODELS** Models of neuron McCulloch – Pitts model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, Multilayer Neural Networks	5
3	**LEARNING METHODS AND PROPAGATION** Learning Methods, Backpropagation, Counterpropagation, ART, BAM, Associative memories	6
4	**INTRODUCTION TO FUZZY LOGIC** Fuzzy sets, Fuzzy model, Fuzzy rule generation Fuzzy inference system, Defuzzification	6
5	**GENETIC ALGORITHMS** Overview, Problem solving using GA, Implementation of GA and GP	5
6	**NEURO-FUZZY SYSTEMS** Introduction, Architecture of a Neuro-Fuzzy system and its applications	4
7	**MACHINE LEARNING:** Supervised learning: Primitive algorithms, Generative algorithms, Support Vector Machine, Ensemble methods. Unsupervised learning: K-means, Principal component analysis, Independent component analysis. Reinforcement learning and control.	6
8	**APPLICATIONS** Applications of GA & GP, Hybrid systems	3

Total no. of turns: 14

List of Experiments:	**Number of turns**

1	Implement OR, AND Using Perceptron in MATLAB Command-line Argument"	2
2	Implement OR, AND Using Perceptron in MATLAB GUI	2
3	Implement OR, AND, X-OR gate, Using back propagation algorithm in MATLAB using Command-line Argument as well as GUI.	2
4	Solve a given problem-1 (Operations) using Fuzzy Logic in MATLAB.	2
5	Solve a given problem-1 (Max-Min Composition) using Fuzzy Logic in MATLAB.	2
6	To find the solution of the function Maximize, given the constraints using GA approach.	1
7	Solve a given problem-1using using Fuzzy Logic in MATLB GUI	1
8	Study GA tool in MATLAB.	1

Course Outcomes: At the end of the course, students will be able to:	
1	Identify and describe soft computing techniques and their roles in building intelligent machines
2	Recognize the feasibility of applying a soft computing methodology for a particular problem
3	Effectively use existing software tools to solve real problems using a soft computing approach
4	Evaluate and compare solutions by various soft computing approaches for a given problem.

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of publication**
1	Neuro fuzzy and soft computing by Jang, Pearson Education	1996
2	Learning and Soft Computing by Kecman, Pearson Education	2001
3	Fuzzy Sets and Fuzzy Logic - Klir and Yuan, PHI	1995
4	Neural Network in computer Intelligence by Fu, TMH	2003
5	Bio-Inspired Artificial Intelligence – Dario Floreano, PHI	2008

Course Name	**:**	**SOFTWARE ENGINEERING**
Course Code	**:**	**CS1503**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Departmental Core Course (DCC-IX)**

Course Objectives:
Students should understand fundamentals of software engineering. They should learn strengths and weaknesses of various software engineering process models used in industrial applications. They should be able to construct software that is reasonably easy to understand, design, develop, test and modify.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO SOFTWARE ENGINEERING** Software, Software Engineering, Myths, Software Process, Work Products, Importance of Software Engineering.	4
2	**SOFTWARE PROCESS MODELS** Standard for Software Process, Waterfall Model, Prototyping Model, Iterative Enhancement Model, Spiral Model, RAD model, 4th Generation models, Formal Methods, Agile Development, Team Software Process, DevOps, Choosing the best Software Process.	6
3	**REQUIREMENT ENGINEERING** Software Requirements, Types of Requirements, Requirement Engineering Cycle, Requirements Specification document, Characteristics of Requirements, Requirement verification and validation.	4
4	**SOFTWARE PROJECT MANAGEMENT** Role of Management in Software Development, Project Estimation Techniques, Staffing, Scheduling, Earned Value Analysis, Software Risks, Software Configuration Management, Software Process and Project metrics.	6
5	**SOFTWARE DESIGN** Process, Data and Behavioral Modeling, Design Concepts, Modularity, Architectural design, Coupling and Cohesion, Top-down and bottom-up design, Object-oriented Analysis, Function-oriented and Object-Oriented Design approach, Software Design Document.	6
6	**CODING AND TESTING** Coding styles and documentation, Testing principles, Testing strategies, Black-box and White-box Testing Techniques, Levels of testing -unit, integration, system, regression, Test Plan, Test Cases Specification, Software debugging, Software Maintenance.	6

7	**SOFTWARE QUALITY** Software Quality Assurance (SQA), SQA tasks, Software amplification and removal, Formal Technical Reviews, Software Quality Factors, ISO 9126, SEI CMM, CMMI, Software Reliability. Software Availability.	4
8	**ADVANCED TOPICS IN SOFTWARE ENGINEERING** Software Process Improvement, Component Based Software Engineering, Web Engineering, Reverse Engineering, Software Engineering challenges of Big Data, Mobile Applications. **COMPUTER AIDED SOFTWARE ENGINEERING** Computer Aided Software Engineering (CASE) and its Scope, CASE support in Software Life Cycle, Architecture of CASE Environment, Upper CASE and Lower CASE, Exposure to CASE tools.	6

List of Experiments:		**Number of Turns**
1	Team Software Project: Requirements Planning, Prepare Models and Designs, Develop and Test the project.	Throughout Semester
2	UML models exercises.	3
3	Programming exercise to understand and develop test cases for Black-box testing.	1
4	Programming exercise to understand and develop test cases for White-box testing.	1

Course Outcomes: At the end of the course, students will be able to:

1	Understand the concepts of Software Process. Select a suitable Software Process for any project.
2	Design and Test the requirements of the software projects.
3	Design and develop projects using concepts like Applet, AWT class, client and server side scripting.
4	Implement the software development processes activities from requirements to verification and validation.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Roger Pressman, Software Engineering: A Practitioner‟s Approach, 7th Edition, McGraw- Hill	2010
2	Ian Sommerville, Software Engineering, 9th Edition, Addision-Wesley.	2016
3	KK Aggarwal and Yogesh Singh, Software Engineering, 3rd Edition, New Age International	2008
4	Pankaj Jalote, A Concise Introduction to Software Engineering, Springer.	2008

Course Name	**:**	**MACHINE LEARNING**
Course Code	**:**	**CS2501/CS4501 (DEC-I / Major Specialization Course)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I) AI&ML**

Course Objectives:
The students should be able to understand the basics of Machine Learning. They should be able to apply different machine learning models using various datasets. They should be able to develop an understanding of the role of machine learning in massive scale automation.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION:** Machine Learning, Feature sets, Dataset division: test, train and validation sets, cross validation, Data handling- missing data, feature scaling, Dimensionality reduction- principal component analysis.	6
2	**BASICS OF MACHINE LEARNING:** Applications of Machine Learning, processes involved in Machine Learning, Introduction to Machine Learning Techniques: Supervised Learning, Unsupervised Learning and Reinforcement Learning, bias-variance trade-off, overfitting-underfitting	6
3	**SUPERVISED LEARNING:** Classification and Regression: K-Nearest Neighbor, Linear Regression, Logistic Regression, gradient descent algorithm, Support Vector Machine (SVM), Evaluation Measures: SSE, MME, R2, confusion matrix, precision, recall, F-Score, ROC-Curve.	6
4	**UNSUPERVISED LEARNING:** Introduction to clustering, Hierarchical clustering, K-means clustering, Density based clustering	6
5	**BAYESIAN LEARNING:** Probability theory and Bayes rule, Naive Bayes learning algorithm, Bayes nets	6
6	**DECISION TREES:** Representing concepts as decision trees, Recursive induction of decision trees, best splitting attribute: entropy and information gain, Overfitting, noisy data, and pruning.	6

7	**REINFORCEMENT LEARNING AND ENSEMBLE METHODS:** Reinforcement learning through feedback network, function approximation, Bagging, boosting, stacking and learning with ensembles, Random Forest	6

Suggested References:

1. Machine Learning: The New AI, By Ethem Alpaydin, The MIT Press, 2016.
2. Machine Learning, Tom M. Mitchell, McGraw Hill Education, 2017.
3. Ethem Apaydin, Introduction to Machine Learning, 2e. The MIT Press, 2010.
4. Kevin P. Murphy, Machine Learning: a Probabilistic Perspective, The MIT Press, 2012.
5. Machine Learning for Dummies, By John Paul Mueller and Luca Massaron, For Dummies, 2016.

Course Outcomes: After completion of course, students would be able to:

1. Understand basic concepts and applications of Machine Learning
2. Compare and Analyze various learning algorithms
3. Apply various machine learning algorithms in a range of real-world applications.

Lab Assignments:

S. No.	Experiment	No. of Turns
1	Mathematical Computing with Python packages: Numpy, Matplotlib, Pandas, ScikitLearn, Tensorflow	2
2	Implementation of data handling and reduction techniques	2
3	Implementation of various classification and regression algorithms - KNN,SVM Naïve Bayes, Decision Trees and Random Forest	4
4	Implementation of Hierarchical clustering, K-means clustering, Density based clustering algorithms	4

Course Name	**:**	**LOGIC AND FUNCTIONAL PROGRAMMING**
Course Code	**:**	**CS2502**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I) AI&ML**

Course Objectives:

- Introduce applicative/declarative style of computing based on mathematical principles, as opposed to the imperative style.
- Develop an understanding of non-conventional programming paradigms and to practice it.
- To advance the state of the art on the theoretical and practical aspects of developing declarative programming tools in logic programming, functional programming and constraint logic programming.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1.	**PROPOSITION LOGIC** Introduction of logic and Functional Paradigm, Propositional Concepts, Semantic Table , Problem Solving with Semantic Table.	**4**
2.	**NATURAL DEDUCTION AND AXIOMATIC PROPOSITIONAL LOGIC** Rules of Natural Deduction, Sequent Calculus, Axiomatic Systems, Meta theorems, Important Properties of AL, Resolution, Resolving Arguments	**6**
3.	**INTRODUCTION TO PREDICATE LOGIC** Objects, Predicates and Quantifiers, Functions, First Order Language, Quantifiers, Scope and Binding, Substitution, An Axiomatic System for First Order Predicate Logic, Soundness and Completeness, Axiomatic Semantic and Programming	**8**
4.	**SEMANTIC TABLEAUX & RESOLUTION IN PREDICATE LOGIC** Semantic Tableaux, Instantiation Rules, Problem-solving in Predicate Logic, Normal forms, Herbrand Universes and H-interpretation, Resolution, Unification, Resolution as a computing Tool.	**8**
5.	**PROLOG CONCEPTS** Programming in PROLOG (Overview), Meta Level Programming and Meta interpreters, Nondeterministic Programming, Incomplete Data Structure, Second Order Programming in PROLOG, Logic Grammars: Definite Clause Grammar, A Grammar Interpreter.	**8**

6.	**LAZY AND EAGER EVALUATION STRATEGIES** Evaluation Strategies, Lazy Evaluation: Evaluation Order and strictness of function, Programming with lazy evaluation, Interactive functional program, Delay of unnecessary Computation, Infinite Data Structure, Eager Evaluation and Reasoning, Recent trends in logical and functional programming.	**8**

List of Experiments:		**Number of Turns**
1	Introduction to PROLOG, LISP and other logic & functional programming languages.	1
2	Write a PROLOG program that answers questions about family members and relationships includes predicates and rules which define sister, brother, father, mother, grandchild, grandfather and uncle.	1
3	Write a PROLOG program for depth-first search and breadth-first search.	1
4	Write a PROLOG program to solve 8-queens problem.	2
5	Write a function in LISP that evaluate a fully parenthesized infix arithmetic expression.	1
6	Write a function in LISP that performs a depth first traversal of binary tree. The function should return a list containing the tree nodes in the order they were visited.	1
7	Write a LISP program for water jug problem.	2
8	Write a LISP program that determines whether an integer is prime.	1
9	Implement various sorting techniques.	2
10	Write a python program to demonstrate user-defined functions.	1
11	Write a python program to display content of input file. (file such csv file, txt file or Jason file)	1

Course Outcomes: At the end of the course, students will be able to:	
1	Understand the concepts of the Logic and Functional programming paradigms.
2	Differentiate between functional programming and logic programming.
3	Implement Lazy and Eager Evaluation Strategies.
4	Understand the use of predicate logic.
5	Apply functional and logic programming for solving a real world problem.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	John Kelly, “The Essence of Logic”, Prentice-Hall India.	1997
2	Saroj Kaushik, “Logic and Prolog Programming”, New Age International ltd.	2007
3	Max Bramer, Logic Programming with Prolog, Springer	2005

4	Masami Hagiya and Philip Wadler, "Functional and Logic Programming" , 8th International Symposium, FLOPS 2006, Fuji-Susono, Japan, April 24-26, 2006, Proceedings	2006
5	Chang, C.L and Lee R.C .T, "Symbolic Logic and Mechanical theorem proving", Elsevier Science, Academic Press, New York	2014
6	J.W. Lloyd, "Foundation of logic programming", New York, 2/E, Springer Verlog,	2012

Course Name	**:**	**Introduction to Internet of Things**
Course Code	**:**	**CS2503**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I) NSS**

Course Objectives:

The main objectives of this course are:	
1.	Understanding of core technology, applications, sensors used and IOT architecture along with the industry perspective.
2.	Principles and operations of different types of sensors commonly used on mobile platform will be taught in a manner that by the end of the course the students will be able to design and implement real time solutions using IOT.

Total No. Lectures: 42

Sr. No.	Course contents	No. of Lectures
1.	**Introduction to IOT** What is IoT, how does it work? Difference between Embedded device andIoT device, Properties of IoT device, IoT Ecosystem, IoT Decision Framework, IoT Solution Architecture Models, Major IoT Boards in Market, Privacy issues in IOT	3
2.	**Setting Up Raspberry Pi/Arduino to Create Solutions** Explore Raspberry Pi, setting up Raspberry Pi, showing working of Raspberry Pi using Secure Shell (SSH) Client and Team Viewer, Understand Sensing actions, Understand Actuators and Microelectromechanical Systems (MEMS).	7
3.	**Communication Protocols in IoT** Types of wireless communication, Major wireless Short-range communication devices, properties, comparison of these devices (Bluetooth, Wireless Fidelity (WiFi), ZigBee, Low-power Wireless Personal Area Network (6LoWPAN)), Major wireless Long-range communication devices, properties, comparison of these devices (CellularIoT, Low-Power Wide-Area Network (LPWAN))	6
4.	**IoT Applications** Industrial Internet 4.0, Applications such as: Smart Homes, Wearables, Smart City, Smart Grids, Connected Car, Connected digital health, telehealth, telemedicine), smart retail.	7

5.	**Sensors** Applications of various sensors: Google Maps, Waze, WhatsApp, Ola Positioning sensors: encoders and accelerometers, Image sensors: camerasGlobal positioning sensors: Global Positioning System (GPS), Global Navigation Satellite System (GLONASS), Indian Regional Navigation Satellite System (IRNSS), Galileo and indoor localization systems, Motion & Orientation Sensors: Accelerometer, Magnetometer, ProximitySensor, Gyroscope, Calibration, - noise modelling and characterization, and - noise filtering and sensor data processing, Privacy & Security	6
6.	**Cloud Computing Services** Introduction to GCP, AWS, Microsoft Azure, IoT Integration of IoT services with the cloud, IoT Data Analytics in the cloud	6
7.	Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring	7

Lab Work:

Sr. No.	Lab contents	No. of Hours
1.	Project based lab work: Design and build systems that will use sensors, communication protocols and actuators	14

Course Outcomes:

At the end of the course, students will be able to:	
1.	Understand the concept of IOT
2.	Study IOT architecture and applications in various fields
3.	Study the security and privacy issues in IOT.
4.	Understand various applications of sensor in Industrial, healthcare, commercial, andbuilding automation.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Vijay Madisetti and ArshdeepBahga, “Internet of Things (A Hands-on- Approach)”, VPT, 1st Edition	2014
2.	Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, Apress Publications, 1st Edition	2013
3.	CunoPfister, “Getting Started with the Internet of Things”, OReilly Media	2011
4.	Kyung, C.-M., Yasuura, H., Liu, Y., Lin, Y.-L., Smart Sensors and Systems, Springer International Publishing	2015

Available MOOCS:

1. https://www.coursera.org/specializations/iot
2. https://www.edx.org/course/introduction-to-the-internet-of-things-iot

Course Name	**:**	**Wireless & Mobile Networks**
Course Code	**:**	**CS2504/CS4502 (DEC-I / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I) NSS**

Course Objectives:

- The students should have a deeper insight into the wireless and mobile communication technologies
- They should develop an understanding of the underlying structure of various wireless and mobile networks
- They should be able to analyze protocols and systems used in wireless and mobile communication

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION** Wireless communication system, mobile radio communication, cellular concepts, characteristics of wireless medium, transmission fundamentals,	6
2	**MULTIPLE ACCESS FOR WIRELESS COMMUNICATION** Introduction, FDMA, TDMA, spread spectrum multiple access-FHMA, CDMA, SDMA, packet radio, CSMA, Capacity of cellular systems	6
3	**WIRELESS NETWORKING** Introduction to wireless networks, overview of wireless networks, development of wireless networks- 2g,3g/4g/5g/6g, traffic routing in wireless networks, wireless data services, CCS, ISDN, SS7, PCS, Protocols for network access, Wireless LAN technology, Bluetooth and wireless PAN	10
4	**WIRELESS SYSTEMS & STANDARDS** AMPS, ETACS, IS-54, IS-136, GSM, IS-95, CT2, DECT, PACs, PDC, PHS, wireless cable TV	10
5	**WIRELESS NETWORK DEVICES** WLAN radio components, wireless network adaptors, wireless network access points, wireless repeaters, bridges, wireless lan switch, wireless routers and gateways, wireless lan Antennas, wireless lan planning and design, wireless network security, wireless wan	10

List of experiments:		**No. of Turns**
1	Case study- Design of a wireless network including all components.	2
2	Study of wireless network design and layout of PEC network.	2
3	Simulation and Implementation of various wireless network protocols	5

4	Configuring of wireless WLAN cards on PCs.	1
5	Projects	4

Course Outcomes:	
At the end of the course, students will be able to:	
1	Independently understand basic wireless and mobile communication concepts
2	Familiarize with medium access protocols for wireless and mobile communication
3	Identify concepts underlying various wireless and mobile networks and standards
4	Understand the principles and functionality of various wireless network devices

Suggested Books:		
Sr. No.	**Name of books / Author/ Publisher**	**Year of Publication/ Reprint**
1.	Theodore S. Rappaport, "Wireless communications – principles and practice" PHI, 2nd	2010
2.	Willian Stallings, "Wireless communications and networks", pearson, 2nd ed	2009
3.	R. Price, "Fundamentals of Wireless networking", TMH	2012
4.	T.L. Singal, "Wireless communications", MGH	2013
5.	I.S. Misra, "Wireless Communications and networks", MGH	2014
6.	CK. Toh, "Adhoc mobile wireless networks-protocols and systems", Pearson	2011
7.	William Stallings, "Data & Computer Communication", PHI, 10th Edition	2013
8.	James F. Kurose and Keith W. Ross, "Computer Networking: A top down approach", Pearson Education, 6th edition.	2017
9.	A.S. Tanenbaum, "Computer Networks", 5th Edition, PHI	2010
10.	G. Keiser, "Local Area Networks", 2nd Edition, TMH	2002
11.	D. Bertesekas and R. Gallager, "Data Networks", 2nd Edition, PHI	2010
12.	B.A. Forouzan, "Data communications and networking", TMH, 5th Edition	2012
13.	B.A. Forouzan, "Local Area Networks", TMH.	2002
14.	B.A. Forouzan, "TCP/IP Protocol Suite", TMH.	2004
15.	Schiller J., Mobile Communications, Addison Wesley.	2000

Course Name	**:**	**Introduction to Information Science**
Course Code	**:**	**CS2505/CS4503 (DEC-I / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I) CIS**

Course Objectives:

- Describe how communities & individuals interact with/in information ecosystems
- Analyze the major tenets of information practice and apply them in multiple contexts
- Connect diverse communities & individuals with appropriate resources
- Explain the dependence of information retrieval on the organization of information

Total No. Lectures: 42

Sr. No.	Course contents	No. of Lectures
1.	Introduction, Data, Information, Knowledge, The Internet, The World-Wide Web Web Search Engines, User Needs	9
2.	Search Strategies, Social Networks, Enterprise Information Systems, Data as an Asset	8
3.	Data Modeling, Relational Databases, Content Management Systems, Linked Open Data, Data Mining	10
4.	Collaboration Support, Information Institutions, Information Professions, Digital Governance, Information Security	10
5.	Privacy, The Filter Bubble, Ethical Design and Ethical Use	5

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1.	Program to collect data from the Web and analysing it.	4
2.	To Clean the data by removing various stop words, delimiters and other things.	3
3.	To program the concept of stemming and lemmatization	3
4.	Program to filter out the useful information from a source.	4

Course Outcomes:

At the end of the course, students will be able to:	
1.	Describe and critically evaluate processes and systems for managing data, information and knowledge by individuals and organizations.
2.	Apply data, information and knowledge management tools to address the actual information problems of an organization by working in teams.
3.	Explain the interactions between the evolution of information technology, information policy, the information professions, and what has been called “the information society.”

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Introduction to Information Science by David BawdenLyn Robinson, FaCet publication	2019
2.	Introduction to Information Technology by V. RajaRaman, PHI learning	2020
3.	Introduction to Information Systems by Brin , McGraw Hill	2019

Course Name	**:**	**MICROPROCESSOR AND ITS APPLICATIONS**
Course Code	**:**	**CS2506**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – I (DEC-I) CIS**

Course Objectives:

Students should be able to understand microprocessor based systems and interfacing techniques. Learn assembly language, assembly directives. Interface microprocessor with memories like RAM and ROM. Interface microprocessor with various peripheral devices. Overview of high end processors.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**ARCHITECTURE OF MICROPROCESSORS** Introduction to the general structure of 8 and 16 bit Microprocessors. Overview of 8085 microprocessor. Overview of 8086 microprocessor. Signals and pin diagram of 8086 microprocessor, Register structure, ALU, Bus Organization, Timing and Control.	**6**
2	**ARCHITECTURE OF A 16-BIT MICROPROCESSOR** Internal organization of 8086, Signal descriptions, Physical memory organization, BIU, EU, Minimum mode 8086 system and timings, Maximum mode 8086 system and timing.	**6**
3	**ASSEMBLY LANGUAGE OF 8086** Addressing modes, Instruction set, Assembler directives and Operators, Data movement instructions, Arithmetic and logic instructions, Program control instructions, Recursive procedures.	**10**
4	**SPECIAL ARCHITECTURAL FEATURES AND RELATED PROGRAMMING** Stack structure, Interrupts and Interrupt service routine, Interrupt programming, Macros, Timings and delays.	**5**
5	**BASIC PERIPHERALS AND THEIR INTERFACING** Memory interfacing, Interfacing I/O ports, Programmable Peripheral Interface (8255), Interfacing A/D and D/A converters.	**3**
6	**SPECIAL PURPOSE PROGRAMMABLE PERIPHERAL DEVICES AND THEIR INTERFACING** Programmable Interval Timer (8253/8254), Programmable Interrupt Controller (8259), Keyboard/Display Controller (8279), Programmable Communication Interface (8251), DMA Controller (8237/8257).	**5**
7	**MICROPROCESSOR'S APPLICATION** Interfacing scanned multiplexed displays and Liquid crystal displays, Interfacing matrix keyboard, Stepper motor interfacing, Case studies of microprocessor based systems, Standards for bus architecture and ports.	**5**

8	**HIGH END PROCESSORS** Introduction to Pentium and onwards	**2**

List of Experiments:		**Number of Turns**
1	To introduce Assembly Language, Assembly Language Fundamentals	1
2	Assembling, Linking and Debugging, Data Allocation Directives	1
3	Programming Data Transfer Instructions (8086 Instruction Set)	2
4	Programming Arithmetic Instructions (8086 Instruction Set)	2
5	Programming Multiply and Divide Instructions (8086 Instruction Set)	1
6	Programming Logical Instruction (8086 Instruction Set)	1
7	Programming Shift Rotate Instructions (8086 Instruction Set)	1
8	Programming Transfer Control Instructions "CALL and RET" (8086 Instruction Set)	1
9	Programming Transfer Control Instructions "Jump" (8086 Instruction Set)	1
10	Programming Transfer Control Instructions "Conditional Jump" (8086 Instruction Set))	1
11	Programming Stack Operation Instructions "PUSH & POP" (8086 Instruction Set)	1

Course Outcomes: At the end of the course, students will be able to:	
1	Program a microprocessor based system.
2	Interface a microprocessor with various peripheral devices.
3	Implement real time embedded applications
4	Use microprocessor peripherals effectively

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	The Intel Microprocessors 8086/8088, 80186/80188, 80286, 80386, Pentium, and Pentium Pro Processor- B.B. Brey, Pearson Education	2009
2	Advanced Microprocessors and Peripherals, Ray and Bhurchandi, 2nd Edition, Tata McGraw Hill	2006
3	Microprocessor and Interfacing - D. V. Hall, McGraw Hill Publishing Co.	1990
4	Microprocessors and Microcomputer based System Design- Rafiquzzaman , PHI	2002

Course Name	**:**	**CONCEPTS IN STATISTICAL LEARNING THEORY**
Course Code	**:**	**CS2507**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – II (DEC-II) AI&ML**

Course Objectives:

This course will provide an overview of the theories and current practices, required by students who intend to specialize in this field, to solve complex problems in Machine Learning Applications for image, video, text and bioinformatics.

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1	**THE LEARNING PROBLEM AND REGULARIZATION:** The learning problem: risk functions, well-posed and ill-posed problems; Tikhonov Regularization; Iterative Regularization via Early Stopping; Manifold Regularization; Structured Sparsity Based Regularization; Empirical and Structural Risk Minimization.	6
2	**LINEAR MODELS FOR REGRESSION:** Subset Selection methods; Shrinkage Methods: Ridge Regression, LASSO, Group LASSO, Least Angle Regression.	8
3	**REGULARIZATION NETWORKS AND SVM**: RKHSs, Mercer's Theorem, Representer theorem, VC Dimension, Hard & Soft margin SVMs; Multiple Kernel Learning, Risk/regret bounds for SVMs, Kernel regression, Convex losses for classification.	8
4	**ON-LINE LEARNING:** Online classification/regression, Online learning from experts, Online convex optimization, Online-to-batch conversions.	6
5	**ADVANCED TOPICS:** Sparse Representation Classifier; Basis Pursuit (BP), M-BP, IrM-BP, M-FOCUSS; M-SBL; Bag-of-Words & Dictionary Learning; Proximal Gradient; ADMM; Auto-encoder & Deep Learning, Transfer Learning & Domain Adaptation;	8
6	**TARGET APPLICATIONS:** Face Recognition and Verification, Video event representation, CBIR in Large Scale Datasets (e.g. ImageNet), Big Data Analytics, etc.	6

Suggested References:

- V. N. Vapnik; Statistical Learning Theory. Wiley, 1998
- T. Hastie, R.Tibshirani, J. Friedman, "The Elements of Statistical Learning: Data Mining, Inference and Prediction", Springer Series in Statistics, 2009.

Kevin R Murphy, "Machine Learning - A Probabilistic Perspective", The MIT Press, 2012

Course Name	**:**	**Natural Language Processing**
Course Code	**:**	**CS2508**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – II (DEC-II) AI&ML**

Course Objectives:
The students should be able to study language and the tools that are available to efficiently study and analyze large collections of text.
They should be able to understand concepts related to language processing and generation

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** A computational framework for natural language, description of English or an Indian language in the frame work, lexicon, algorithms and data structures for implementation of the framework, Finite state automata, The different analysis levels used for NLP (morphological, syntactic, semantic, pragmatic, Recursive and augmented transition networks. Applications like machine translations.	**7**
2	**WORD LEVEL AND SYNTACTIC ANALYSIS** Word Level Analysis: Regular Expressions, Finite-State Automata, Morphological Parsing, Spelling Error Detection and correction, Words and Word classes, Part-of Speech Tagging. Syntactic Analysis: Context-free Grammar, Constituency, Parsing-Probabilistic Parsing. Machine-readable dictionaries and lexical databases, RTN, ATN.	**10**
3	**SEMANTIC ANALYSIS** Semantic Analysis: Meaning Representation, Lexical Semantics, Ambiguity, Word Sense Disambiguation. Discourse Processing: cohesion, Reference Resolution, Discourse Coherence and Structure. Knowledge Representation, reasoning.	**10**
4	**NATURAL LANGUAGE GENERATION** Natural Language Generation (NLG): Architecture of NLG Systems, Generation Tasks and Representations, Application of NLG. Machine Translation: Problems in Machine Translation, Characteristics of Indian Languages, Machine Translation Approaches, Translation involving Indian Languages.	**8**
5	**INFORMATION RETRIEVAL AND LEXICAL RESOURCES**	**7**

	Information Retrieval: Design features of Information Retrieval Systems, Classical, Non-classical, Alternative Models of Information Retrieval, valuation Lexical Resources: World Net,Frame Net, Stemmers, POS Tagger.	

List of Experiments		**Number of Turns**
1	Implement program to perform automatic word analysis	2
2	Implement program to perform word generation	3
3	Implement programs related to morphology, N-Grams, N-Grams Smoothing	3
4	Implementation of Hidden Markov Models	3
5	Implement program to build POS Tagger, Chunker	3

Course Outcomes: At the end of the course, students will be able to:	
1	Learn natural language processing with manual and automated approaches.
2	Learn computational frameworks for natural language processing.

Suggested Books:		
	Name of Book/ Authors/ Publisher	**Year of Publication/ Reprint**
1	Natural Language understanding by James Allen, Pearson Education	2008
2	NLP: A Paninian Perspective by Akshar Bharati, Vineet Chaitanya, and Rajeev Sangal, Prentice Hall	1995
3	Meaning and Grammar by G. Chirchia and S. McConnell Ginet, MIT Press	2000
4	An Introduction to Natural Language Processing, Computational Linguistics, and Speech Recognition by Daniel Jurafsky and James H. Martin, Pearson Education	2008
5	Natural language processing in Prolog by Gazdar, & Mellish, Addison-Wesley	1989

Course Name	**:**	**APPLIED CRYPTOGRAPHY**
Course Code	**:**	**CS2509**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of course	**:**	**Department Elective – II (DEC-II) NSS**

Course Objectives:
The students should be able to understand basic number theory, with a focus on computational aspects and applications in cryptography. They should understand basic design principals of symmetric and asymmetric cryptography. They should learn how cryptanalytic attacks work and thereby how to avoid common design flaws.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**FOUNDATIONS** Substitution Ciphers and Transposition Cipher, Block cipher, Stream cipher.	**4**
2	**CRYPTOGRAPHIC PROTOCOLS** Introduction to Protocols, Communications using Symmetric Cryptography, One-Way Functions, Communications using Public-Key Cryptography, Digital Signatures, Digital Signatures with Encryption, Random and Pseudo-Random Sequence Generation, Basic Protocols: Key Exchange, Authentication, Authentication And Key Exchange, Formal Analysis Of Authentication And Key-Exchange Protocols, Multiple-Key Public-Key Cryptography.	**8**
3	**CRYPTOGRAPHIC TECHNIQUES** **Key Length & Management:** Symmetric Key Length, Public-Key Key Length, Comparing Symmetric And Public-Key Key Length, **,**Generating Keys, Nonlinear Keyspaces, Transferring Keys, Verifying Keys, UPDATING KEYS, Storing Keys, Backup Keys.	**10**
4	**CRYPTOGRAPHIC ALGORITHMS** Mathematical Theory, NUMBER THEORY, FACTORING, Prime Number Generation, Discrete Logarithms in a Finite Field, Data Encryption Standard: Description of DES, Security of DES, Differential And Linear Cryptanalysis, Design Criteria, DES Variants, DES modes of operation, Other Stream Ciphers and One-Way Hash Functions RC4, One-Way Hash Functions, MD5, Secure Hash Algorithm (SHA), Message Authentication Codes	**8**
5	**PUBLIC-KEY ALGORITHMS** Background, RSA, Elliptic Curve Cryptosystems, Digital Signature Algorithm, Key-Exchange Algorithms: DIFFIE-HELLMAN	**8**
6	**IMPLEMENTATIONS** PRETTY GOOD PRIVACY (PGP), SMART CARDS	**4**

List of Experiments:		**Number of Turns**
1	Install JCRYPT tool (or any other equivalent) and demonstrate Asymmetric, symmetric crypto algorithm, hash and digital/PKI Signatures.	**3**
2	Using Wireshark / Ethereal Protocol Analyser • How to capture the network's traffic. • How to save the filtered traffic. • Saving the traffic in file in pcap or in log format.	**2**
	• Study and analyzing the captured packets. • Creating a case where the server and client had a conversation. • Eavesdropping the particular IP in the network.	

3	Frequency Analysis This lab will introduce students to frequency analysis, a method used to decode ciphertext by studying the frequency of letters.	**2**
4	Hash Function This lab will introduce students to hash functions and how they provide for message integrity. Students will be asked to use hashing to detect if an encrypted message has been tampered with. Students will also need to show that this integrity check can be bypassed by tampering with both the ciphertext and the hash code.	**2**
5	Hands On: Some sample Problems which can be given to the students • How to Ensure the validity of Forensic Evidence by Using a Hash Function? • How to extract evidence from a Mobile Phone? • How to use Open SSL to generate digital Signatures • Conduct Performance Analysis between various Symmetric Algorithms	**4**

Course Outcomes: At the end of the course, students will be able to:	
1	Apply the basic rules of public key and symmetric encryption for practical cryptographic problems.
2	Demonstrate the design and use of hash functions, digital signatures, and key distribution with a wide range of key types.
3	Design and implement a cryptography algorithm.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Applied Cryptography protocols, algorithms, and source code in C, Second Edition, Bruce Schneier, John Wiley & Sons	1996
2	Handbook of Applied Cryptography, by Alfred J. Menezes, Paul C. van Oorschot and Scott A. Vanstone, CRC Press ISBN: 0-8493-8523-7.	1996

Course Name	**:**	**High Speed Networks**
Course Code	**:**	**CS2510**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of course		**Department Elective Course – II (DEC-II) NSS**

Course Objectives:

- To introduce the basic concepts of high-speed LAN technologies
- To get a basic introduction to key concepts and techniques underlying high speed WAN technologies
- To learn the architecture and issues related high speed transport and network protocols
- To understand the functioning of different types of high-speed wireless networks

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
6.	LAN Technologies Fast Ethernet (802.3u), Gigabit Ethernet (802.3z), 10Gigabit ethernet (802.3ae), ATM, PoE (802.3af), EFM (802.3ah), EEE (802.3az), 40Gbps & 100Gbps Ethernet, latest high-speed versions of ethernet, RPR, VLAN, NAS	10
7.	WAN Technologies Packet over SONET/SDH (PoS), Multiprotocol Label Switching (MPLS), ATM, and Frame Relay, Subnet Bandwidth Management (SBM), QoS Architectures, QoS Support for Multicast	6
8.	Transport protocols High speed versions of TCP, indirect TCP, snooping TCP, mobile TCP, fast retransmit/fast recovery, transmission/timeout freezing, selective retransmission, TCP over 3G/4G networks, performance enhancing proxies	10
9.	Network Protocols Next generation networks, network control and service architectures, high speed network devices, interfaces and controllers, NAT, DHCPv6, IPv6, Mobile IPv6, multicasting, performance evaluation, programmable networks, content delivery networks, Network solutions for fully distributed architectures (Clouds, Grids)	10
10.	High speed wireless networks 4G/5G/6G, wireless broadband, mobile wireless broadband, WiFi4/5/6/6e and other latest high speed versions of wireless LAN, security issues in high speed wireless networks	6

List of experiments:	**No. of Turns**

4.	Practicals based on ethernet switches and interconnection of devices and their configuration	4
5.	Practicals based on routing switches and interconnection of devices and their configuration	4
6.	Simulation and implementation of protocols for high speed networks and high speed wireless networks	6

Course Outcomes:	
At the end of the course, students will be able to:	
8.	Grasp the concepts and characteristics of high speed LAN technologies
9.	Understand various types of high-speed WAN technologies
10.	Identify the various design issues of high speed transport and network protocols
11.	Understand the working principles and design issues of various high speed wireless networks

Suggested Books:

Sr. No.	**Name of books / Author/ Publisher**	**Year of Publication/ Reprint**
5.	Rich Seifert, "Gigabit Ethernet: Technology and Applications for High-Speed LANs" Addison wesley	2017
6.	G. Carle, M. Zibchart, "Protocols for High Speed Networks" springer	2016
7.	D.D. Choudhary, "High speed LAN technology handbook", springer	2010
8.	James F. Kurose and Keith W. Ross, "Computer Networking: A top down approach", Pearson Education, 6th edition.	2017
9.	A.S. Tanenbaum, "Computer Networks", 5th Edition, PHI	2010
10.	G. Keiser, "Local Area Networks", 2nd Edition, TMH	2002
11.	D. Bertesekas and R. Gallager, "Data Networks", 2nd Edition, PHI	2010
12.	William Stallings, "Data & Computer Communication", PHI, 10th Edition	2013
13.	B.A. Forouzan, "Data communications and networking", TMH, 5th Edition	2012
14.	B.A. Forouzan, "Local Area Networks", TMH.	2002
15.	B.A. Forouzan, "TCP/IP Protocol Suite", TMH.	2004
16.	Schiller J., Mobile Communications, Addison Wesley	2000
17.	Stallings W., Wireless Communications and Networks, Pearson Education	2005

18.	Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc	2002
19.	Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc	2000
20.	Pandya Raj, Mobile and Personal Communications Systems and Services, PHI	2004

Course Name	**:**	**Web Information Retrieval and crawling**
Course Code	**:**	**CS2511**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – II (DEC-II) CIS**

Course Objectives:

- To learn advanced and cutting edge state-of-the-art knowledge and implementation in information retrieval for WWW.
- To read and understand concept and working of various types of search engines and its component, beyond that of the traditional textbook level.
- To conduct independent project and to equip for scholarly research in information retrieval for WWW.

Total No. Lectures: 42

Sr. No.	Course contents	No. of Lectures
1	**INTRODUCTION TO World Wide Web:** Various version of WWW and differences between them, Surface PIW web, hidden web, dark web. Working of WWW, World wide web and Internet, The ethos of the web	8
2	**Search Engine and Web crawlers:** Working of Search engine and its components, Various types of Search engines, Web crawlers, indexer, difference between web scrapper and web crawler, Document Conversion Storing the Documents, Detecting Duplicates, Noise Detection and Removal Search engine algorithms, keyword search and user behaviour	8
3	Comparative study of various open source web crawler, BeautifulSoup, Requests and Selenium, Focused web crawler, Hidden web crawler, Mobile crawler, incremental web crawler, Robots.txt, Challenges in crawling the Web	8
4	Focused web crawling techniques using soft computing techniques, Performance metrics for various type of Web crawlers, Precision, Recall, F-measure	9
5	Ranking with Indexes: Abstract Model of Ranking, Inverted indexes, Information Retrieval as Classification, Social Search: Networks of People and Search Engines, User tagging, Searching within Communities, Filtering and recommending, Metasearch	9

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1	To demonstrate and understand the working of various search engines	3
2	Study various open soruce web crawler and how to extend them as per requirements.	3

3	Implementing web crawlers using various AI techniques	4
4	Extending the crawling strategies for hidden web and mobile web crawling.	4

Course Outcomes:

At the end of the course, students will be able to:	
1.	Demonstrate the knowledge of, web search, web crawling, dictionaries and tolerant retrieval, index construction and compression, etc.
2.	Practice examples of information retrieval and open source tools, and implement example information retrieval applications
3.	Practice examples of web crawling and using machine learning approaches for web crawling.
4.	Demonstrate the ability to do research in information retrieval: able to read/understand current research papers and implement research group project in information retrieval.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	"Information Retrieval: Implementing and Evaluating Search Engines" by Stefan Buettcher, Charles L. A. Clarke, Gordon V. Crmack, ISBN: 978-0262026512, MIT Press	2010
2	"Search Engines: Information Retrieval in Practice" by Bruce Croft, Donald Metzler, Trevor Strohman, ISBN: 978-0136072249, Addison-Wesley	2019

Course Name	**:**	**Clean Coding Practices**
Course Code	**:**	**CS2512**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – II (DEC-II) CIS**

Course Objectives:

- Understand the importance of clean code and refactoring.
- Learn and practice some basic practices for clean-code.
- Understand the best practices for performing the refactoring.
- Understand the importance of unit tests and TDD for clean code

Total No. Lectures: 42

Sr. No.	Course contents	No. of Lectures
1.	**Introduction:** Why this is needed, Foundations, Ownership, Resources Principles Tools & Core Principles, Self Documenting Code, DRY Principles Boundaries **Naming conventions**: Names with meaning, Class Names, Method Names Warning Signs	10
2.	**Writing functions:** Size is everything, Single Responsibility Principles Arguments, Side Effects, Fail Fast, Return early	8
3.	**Comments and usage guidelines:** When to write them, Intent, Warning Signs, Necessary comments, Clean Comments	8
4.	**Formatting:** Purpose and types of formatting, Excessive Indentation, Specific Refactoring Techniques Using Resharper Extract/Inline method, Extract/Inline variables, fields and parameters, Change method signature, Extract super class/interface, Pull members up/Push members down	9
5.	**Objects and data structures**: Law of Demeter, Data Abstraction and Symmetry, How to Handle Errors	7

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1.	Clean programs for self-documentation and logical names.	4
2.	Clean programs for smaller sizes and robustness	3
3.	Usage of comments for other programmers	3
4.	Clean formatting and objects and data structures	4

Course Outcomes:

At the end of the course, students will be able to:	
1.	Make improvements to the quality of their code
2.	Give logical names to the variables and functions
3.	Write programmer readable code and data structures

Bibliography:

Sr. No.	**Book Detail**	**Year of Publication**
1.	Clean code by Robert C Martin Pearson education	2012
2.	The Clean coder by Martin and Heusser Pearson Education	2015
3.	Clean Code in C#: Refactor your legacy C# code base and improve application performance by applying best practices authored by Jason Alls Packt Publishers	2020

Course Name	**:**	**Compiler Design**
Course Code	**:**	**CS3501**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Honours Course – 2 (DHC-2)**

Total No. Lectures: 42

Course Objectives:

- To learn the various phases of compiler.
- To learn the various parsing techniques.
- To understand intermediate code generation and run-time environment.
- To learn to implement front-end of the compiler.
- To learn to implement code generator

Course Contents:

Sr. No.	Course contents	No. of Lectures
1	**INTRODUCTION TO COMPILERS:** Structure of a compiler – Lexical Analysis – Role of Lexical Analyzer – Input Buffering –Specification of Tokens – Recognition of Tokens – Lex – Finite Automata – Regular Expressions to Automata – Minimizing DFA	7
2	**Overview of the Translation Process:** A Simple Compiler, Difference between interpreter, assembler and compiler. Overview and use of linker and loader, types of Compiler, Analysis of the Source Program, The Phases of a Compiler, Cousins of the Compiler, The Grouping of Phases, Lexical Analysis, Hard Coding and Automatic Generation Lexical Analyzers, Front-end and Back-end of compiler, pass structure	7
3	**SYNTAX ANALYSIS:** Role of Parser – Grammars – Error Handling – Context-free grammars – Writing a grammar –Top Down Parsing – General Strategies Recursive Descent Parser Predictive Parser-LL(1) Parser-Shift Reduce Parser-LR Parser-LR (0)Item Construction of SLR Parsing Table - Introduction to LALR Parser – Error Handling and Recovery in Syntax Analyzer-YACC.	7
4	**INTERMEDIATE CODE GENERATION:** Syntax Directed Definitions, Evaluation Orders for Syntax Directed Definitions, Intermediate Languages: Syntax Tree, Three Address Code, Types and Declarations, Translation of Expressions, Type Checking.	7
5	**RUN-TIME ENVIRONMENT AND CODE GENERATION:** Storage Organization, Stack Allocation Space, Access to Non-local Data on the Stack, Heap Management – Issues in Code Generation – Design of a simple Code Generator	7
6	**CODE OPTIMIZATION:** Principal Sources of Optimization – Peep-hole optimization – DAG- Optimization of Basic Blocks Global Data Flow Analysis – Efficient Data Flow Algorithm.	7

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1	Design a lexical analyzer for given language and the lexical analyzer should ignore redundant spaces, tabs and new lines. It should also ignore comments.	3
2	Write a C program to identify whether a given line is a comment or not. Write a C program to test whether a given identifier is valid or not.	3
3	Write a C program to simulate lexical analyzer for validating operators	3
4	To Study about Lexical Analyzer Generator(LEX) and Flex(Fast Lexical Analyzer)	3
5	Write a Lex program to count the number of comment lines in a given C program. Also eliminate them and copy that program into separate file.	2

Course Outcomes:

At the end of the course, students will be able to:	
1.	Understand the basic concepts and application of Compiler Design
2.	Apply their basic knowledge Data Structure to design Symbol Table, Lexical Analyser , Intermediate Code Generation, Parser (Top Down and Bottom Up Design) and will able to understand strength of Grammar and Programming Language.
3.	Understand various Code optimization Techniques and Error Recovery mechanisms.
4.	Understand and Implement a Parser.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	Compilers: Principles, Techniques and Tools By Aho, Lam, Sethi, and Ullman, Second Edition, Pearson, 2014	2014
2	Compilers: Principles, Techniques and Tools By Aho, Sethi, and Ullman, Addison-Wesley,	2015
3	Advanced Compiler Design and Implementation By Muchnick, Morgan and Kaufmann.	2019

Semester VI

Semester VI

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS8601	Internship Training (Optional)	0	0	24	12	Internship
(OR)							
Students Opting for course work will do department elective (4 credits), open elective (4 credits) and Project Work							
1.	CS2601 to CS2602	Department Elective	3	0	2	4	DE
2.	CS6601 to CS6602	Open Elective*	3	0	2	4	OE
3.	CS7601	Project Work	0	0	8	4	Project
Total Credits						12	

*Open Elective course will not be offered to B.Tech. (CSE) students

Department Elective

Sr. No.	Course Code	Course Name	L	T	P	Credits	Specialization domain
1.	CS2601	Knowledge Representation and Reasoning	3	0	2	4	AI& ML
2.	CS2602	Advanced Computer Networks	3	0	2	4	NSS

Open Elective*

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS6601	Data and Communication Networks*	3	0	2	4	OE
2.	CS6602	IT Concepts in Engineering*	3	0	2	4	OE

*Open Elective course will not be offered to B.Tech. (CSE) students

Course Name	**:**	**Knowledge representation and reasoning**
Course Code	**:**	**CS2601**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective (DE) AI & ML**

Course Objectives:

- To learn predicate logic, a universal symbolic language to express the basic constructs
- To introduce Logic based concepts and techniques
- To learn theoretical and practical applications in knowledge representation system

Course Contents: **Total No. Lectures: 42**

Sr. No.	Course contents	No. of Lectures
1	**Introduction**: Knowledge based systems, The role of logic, semantics, Explicit and implicit beliefs, Knowledge engineering, vocabulary	4
2	Propositional Logic, Resolution and Horn Clauses, Representing Knowledge in Predicate Logic, Soundness and completeness, Handling Propositional Formulae, Reduction, Belief operators, Characteristic axioms, Non-monotonic logics, Reasoning in Default Logic, Fixpoint semantics for default logic, Properties of default logic	9
3	**Modeling and reasoning**: Equivalence of logic programs, Cumulative logics, Well-founded semantics for logic programs, Consequence relations, preferential reasoning, Answer set programming, Abductive reasoning, Qualitative reasoning, Constraint satisfaction	7
4	**Knowledge representation**: Ontology languages for the Semantic Web, Rules, Representation of Domain Knowledge, Object-oriented representation, inheritance reasoning, Ontology design patterns, Linked data publishing with ODPs	8
5	**Overview RDF** semantics, SPARQL, BGP, Triples, Formalization and representation of knowledge with RDF and OWL	6
6	**Knowledge Representation in the Web**: Representing data with HTML, Formalization and representation of information with DTD, XML Schema,	8

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1	To Translate the sentences from English to first order logic	4
2	To implement Horn clauses and program positive Horn clauses and negative Horn clauses.	3
3	To build an ontology and its mappings to query	2
4	Write RDF document in Turtle syntax	2
5	Write SPARQL queries using SELECT, CONSTRUCT, ASK, DESCRIBE	3

Course Outcomes:

At the end of the course, students will be able to:	
1.	Understand the fundamental principles of logic-based Knowledge Representation
2.	Model simple application domains in a logic-based language
3.	Understand several widely used knowledge representation languages

Bibliography:

Sr. No.	**Book Detail**	**Year of Publication**
1.	R. J. Brachman, H. J. Levesque, *Knowledge Representation and Reasoning*, Elsevier	**2004**
2.	Handbook of Knowledge Representation. Frank van Harmelen, Vladimir Lifschitz and Bruce Porter (Eds). Foundations of Artificial Intelligence	2008
3.	Foundations of Semantic Web Technologies. Chapman & Hall/ CRC Textbooks in Computing. Pascal Hitzler, Markus Kroetsch, and Sebastian Rudolph	2009

Course Name	**:**	**Advanced Computer Networks**
Course Code	**:**	**CS2602**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective (DE) NSS**

Course Objectives:

- The students should have a deeper insight into the advanced topics of computer networks and crucial protocols in computer networks.
- They should develop an understanding of the underlying structure of networks and how they operate as client/server architecture, network scalability.
- They should be able to analyze simple protocols and independently study literature concerning computer networks

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1.	**INTRODUCTION** Overview of computer networks; seven-layer architecture; TCP/IP suite of protocols.	3
2.	**MEDIUM ACCESS** MAC protocols for high-speed networks -Gigabit Ethernet,RPR etc.	4
3.	**INTERNETWORKING AND ROUTING** Internetworking problem – packet switching; Delivery and Forwarding of IPpackets; Brief introduction to IPv4, scaling IP address space, Unicast routing protocols, IPv6 protocol	7
4.	**RESOURCE MANAGEMENT** Data traffic – traffic descriptor, traffic profiles; Congestion – definition, network performance; Congestion control techniques – open loop congestion control and closed loop congestion control; Congestion Control in TCP.	5
5.	**QUALITY OF SERVICE** Introduction; Flow characteristics; Flow classes; Techniques to improve QoS – Scheduling, Traffic shaping, Resource Reservation, Admission control; Internet QoS models – Integrated services, Differentiated services.	6
6.	**GROUP COMMUNICATION** Introduction; IP Multicast addresses; IGMP – group management, messages, operation; Multicast Routing and Transport, Multicast routing protocols – MOSPF, DVMRP, CBT, PIM, MBONE.	7
7.	**TRANSPORT LAYER PROTOCOLS** TCP protocol dynamics; new options in TCP; brief introduction to SCTP, T/TCP.	6
8.	**WIRELESS NETWORKS**	4

	Wireless PAN, LAN, MAN, WAN; Mobile network layer; Mobile transport layer.	

List of experiments:		**No. of Turns**
1.	Implementation of various protocols	4
2.	Programs related to resource management	3
3.	Programs related to group communication	3
4.	Projects	4

Course Outcomes:	
At the end of the course, students will be able to:	
1.	Independently understand basic computer network technology.
2.	Identify concepts underlying Internet protocol, their main characteristics and functionality and their extension.
3.	Understand various traffic parameters, congestion control techniques and QoS
4.	Understand the principles and functionality of various multicast and transport protocols.
5.	Understand the needs of wireless networks and some extensions to mobility at various layers.

Suggested Books:

Sr. No.	**Name of books / Author/ Publisher**	**Year of Publication/ Reprint**
1.	William Stallings, “Data & Computer Communication”, PHI, 10th Edition	2013
2.	James F. Kurose and Keith W. Ross, “Computer Networking: A top down approach”, Pearson Education, 6th edition.	2017
3.	A.S. Tanenbaum, “Computer Networks”, 5th Edition, PHI	2010
4.	G. Keiser, “Local Area Networks”, 2nd Edition, TMH	2002
5.	D. Bertesekas and R. Gallager, “Data Networks”, 2nd Edition, PHI	2010
6.	B.A. Forouzan, “Data communications and networking”, TMH, 5th Edition	2012
7.	B.A. Forouzan, “Local Area Networks”, TMH.	2002
8.	B.A. Forouzan, “TCP/IP Protocol Suite”, TMH.	2004
9.	Schiller J., Mobile Communications, Addison Wesley.	2000

Course Name	**:**	**Data and Communication Networks**
Course Code	**:**	**CS6601**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Open Elective (OE)**

Course Objectives:

- To understand basic concepts of transmission technologies
- To learn the underlying structure of networks and how they operate
- To analyze simple protocols and independently study their working principles

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1.	Data and Signals, periodic analog signals, digital signals, data rate limits, digital transmission, transmission modes, signal conversions, bandwidth utilization, spread spectrum, transmission media, switching	10
2.	Link layer addressing, error detection and correction, data link control, MAC protocols, wired networks	8
3.	Network layer services, performance, addressing, forwarding of packets, network layer protocols,	8
4.	Transport layer services, Go-back-N, selective repeat, UDP, TCP	8
5.	Client server programming, http, ftp, email, dns	8

List of experiments:		**No. of Turns**
1.	Implementation of various protocols	4
2.	Programs related to error detection, gobackn, selective repeat	2
3.	Programs related to implementation of udp and tcp	2
4.	Simulation experiments based on wireshark	6

Course Outcomes:	
At the end of the course, students will be able to:	
1.	Independently understand basic computer network technology.
2.	Familiarize with various protocols used at various layers
3.	Understand the principles and functionality of various network applications

Suggested Books:

Sr. No.	Name of books / Author/ Publisher	Year of Publication/ Reprint
1.	B.A. Forouzan, “Data communications and networking”, TMH, 5th Edition	2013
2.	William Stallings, “Data & Computer Communication”, PHI, 10th Edition	
3.	James F. Kurose and Keith W. Ross, “Computer Networking: A top down approach”, Pearson Education, 6th edition.	2017
4.	A.S. Tanenbaum, “Computer Networks”, 5th Edition, PHI	2010
5.	G. Keiser, “Local Area Networks”, 2nd Edition, TMH	2002
6.	D. Bertesekas and R. Gallager, “Data Networks”, 2nd Edition, PHI	2010
7.	B.A. Forouzan, “Local Area Networks”, TMH.	2002
8.	B.A. Forouzan, “TCP/IP Protocol Suite”, TMH.	2004

Course Name	**:**	**IT concepts in Engineering**
Course Code	**:**	**CS6602**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Open Elective (OE)**

Course Objectives:
The students should be able to understand the concepts of Web Technology, RBMS and, Software Engineering

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**WEB TECHNOLOGIES AND INTRODUCTION TO USER INTERFACE AND WEB TECHNOLOGIES :** web fundamentals – types web content – HTML – text formatting tags in HTML – HTML form elements - and tags - text formatting using CSS : embedded CSS, inline CSS and external CSS – JavaScript and its features. **INTRODUCTION TO Python** : Introduction,: gitHub, Functions, Booleans and Modules, Sequences, Iteration and String Formatting, Dictionaries, Sets, and Files, Exceptions, Testing, Comprehensions Advanced Argument Passing, Lambda -- functions as objects	14
2	**SOFTWARE ENGINEERING** Software Engineering : Definition – role of software and software crisis – SDLC models : waterfall model, incremental model and spiral model software testing – static & dynamic testing – types testing : unit testing, integration testing, system testing, performance testing and regression testing.	14
3	**RELATIONAL DATABASE MANAGEMENT SYSTEM** RDBMS- data processing – the database technology – data models- ER modeling concept –notations – converting ER diagram into relational schema - Logical database design - normalization (1NF, 2NF and 3NF). SQL – DDL statements – DML statements – DCL statements – Joins - Sub queries – Views - Database design Issues – SQL fine tuning.	14

List of Experiments:		**Number of Turns**
1	Web tech program HTML based forms and CSS fundamentals	2
2	Program related to python functions /sequence,	3
3	Lab related to software testing tools. test case design, Programming exercise to understand and develop test cases for Black-box testing/ White-box testing.	3
4	Software engineering modeling program analysis tools in the software life cycle. UML models exercises.	2

5	Database lab related Software installation and SQL DDL/DML queies	3
6	Perform joins and create views etc.on a given database	2

Course Outcomes: At the end of the course, students will be able to:	
1	Demonstrate web fundamentals using HTML,css, Write,execute python programs to solve problems
2	compare the software models and know software testing fundamentals
3	Design and develop SQL queries for database applications and know about database normalization

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Thomas Powell, HTML and CSS: The complete reference	Latest edition
2	Think Python: How to Think Like a Computer Scientist	Latest edition
3	Henry F Korth, Abraham Silberschatz, "Database system concepts", Second ed., McGraw-Hill International editions, Computer Science series	Latest edition
4	Software Testing, Author: Ron Patton	Latest edition
5	Software engineering ROGER pressman	Latest edition
6	The Art of Software Testing, Author: Glenford J. Myers, Corey Sandler, Tom Badget	Latest edition
7	Software Engineering, , Pankaj Jalote, Narosa Publishers	Latest Edition

Semester VII

Semester VII

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	HS2701 / HS2702 / HS2703 / HS2704 / HS2705 / HS2706 / HS2707 / HS2708	Anthropology / Appreciation of Art / English Literature / History / Introduction to Art History / Philosophy- an Introduction / Political Science / Public Administration	2 3 2 3 3 3 2 2	1 0 1 0 0 0 1 1	0 0 0 0 0 0 0 0	3	HSM-III
2.	CS2701 to CS2706	Department Elective Course – III (DEC-III)	3	0	2	4	DEC-III
3.	CS2707 to CS2712	Department Elective Course – IV (DEC-IV)	3	0	2	4	DEC-IV
4.	CS6701/ CS5701	*Open Elective –III/Minor Specialization Course (MSC)	3	0	2	4	OE-III/MSC
5.	CS6702	*Open Elective –IV	3	0	2	4	OE-IV
6.	CS7701	Major Project-I	0	0	4	2	Project
					Total Credits	21	
Department Honours Course – 3 (DHC-3)							
7.	CS3701	Special Topics in Wireless and Mobile Networks	3	0	2	4	DHC-3
					Total Credits (Including Honours)	25	

*Open Elective course will not be offered to B.Tech. (CSE) students

Department Elective Course - III (DEC-III)

Sr. No.	Course Code DEC-III/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2701	Pattern Recognition	3	0	2	4	AI& ML
2.	CS2702/CS4701	Deep Learning	3	0	2	4	AI& ML
3.	CS2703	Network Administration and Management	3	0	2	4	NSS
4.	CS2704/CS4702	Mobile and Wireless Network Security	3	0	2	4	NSS
5.	CS2705/CS4703	Distributed Algorithm Design	3	0	2	4	CIS
6.	CS2706	Agile Software Development and Modern Practices	3	0	2	4	CIS

Department Elective Course - IV (DEC-IV)

Sr. No.	Course Code DEC-IV/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2707	Advances of Intelligent and Learning Agents	3	0	2	4	AI& ML
2.	CS2708/CS4704	Advanced Artificial Intelligence	3	0	2	4	AI& ML
3.	CS2709/CS4705	Wireless Sensor Networks	3	0	2	4	NSS
4.	CS2710	Mobile Computing	3	0	2	4	NSS
5.	CS2711	Digital Image Processing	3	0	2	4	CIS
6.	CS2712/CS4706	Cloud Computing	3	0	2	4	CIS

Open Elective – III (OE-III) / Minor Specialization Course (MSC)

Sr. No.	Course Code OE/MSC	Course Name	L	T	P	Credits	Category
1.	CS6701/ CS5701	Computer Networks*	3	0	2	4	OE-III/MSC

*Open Elective course (Computer Networks) will not be offered to B.Tech. (CSE) students

Open Elective – IV (OE-IV)

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS6702	Computer Architecture & Organization*	3	0	2	4	OE-IV

*Open Elective course (Computer Architecture & Organization) will not be offered to B.Tech. (CSE) students

Course Name	**:**	**Anthropology**
Course Code	**:**	**HS2701**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:

1. The course is designed to teach basics and fundamentals of anthropology and its scope.
2. This is a foundation course in social cultural anthropology conveying to students the meaning of the key concepts and to familiarize the students with the elementary concepts of the discipline.
3. To teach the basic and fundamental concepts of Anthropology and their applications.

Total No. of Lectures-28

Lecture wise Breakup		**No. of Lectures**
1	Introduction to Anthropology: Definition, historical development, perspectives and subfields, Relationship of anthropology with allied disciplines like History, Sociology, Psychology, Geography, Human Biology and Medicine, Scope and Applications of anthropology.	5
2	Anthropological perspective and orientation; Scope and relevance of Social Anthropology; Cultural Anthropology; Relationship of Social Anthropology with Sociology.	3
3	Concepts of society and culture; status and role; groups and institution, social stratification, and civil society.	3
4	Social fact; social action; social conflict; social system	3
5	Basic Concepts: Society, Culture, Civilization; differences between culture and civilization; Culture Trait, Culture Complex; Community, Groups and Institutions.	4
6	Social/ Cultural Anthropology: Definition, aims and scope of social / cultural anthropology, Sub-divisions of social-cultural anthropology, Ethnography and Ethnology, Relationship of social anthropology with other disciplines, especially sociology, psychology and history, Definition and meaning of culture.	5
7	Physical Anthropology: Definition, scope and objectives of Physical Anthropology, its relationship with allied disciplines. Theories of evolution: contributions of Darwin and Lamark; synthetic theory. Morphological and anthropometric criteria of race (skin colour, hair, face, head, ear, nose, eyes and physique).	3

8	Theory and practice of ethnographic fieldwork; survey research; comparative and historical methods.	2

Total No. of Tutorials-14

Hour wise Breakup		**No. of Tutorials**
	Tutorials based on Lectures	14

Course Outcomes:	
1	To make the understand students about social and cultural anthropology.
2	The students will be able to identify the function and application of Anthropology theory in social sciences.
3	The students will learn about social structure and how it shapes and influences social interactions.

S.No.	**Suggested Readings**	**Year**
	Text Books	
1	"Anthropology", Stanford C., Allen J.S. and Anton S.C. , New Delhi: Oxford & IBH Publishing Co.	2010
2	"Key Concepts in Social and Cultural Anthropology",Rapport N. and Overing J, London: Routledge.	2004
	Reference Books	
1	"Exploring Biological Anthropology. The Essentials", USA: Prentice Hall Publishing.	2012
2	"History and Theory in Anthropology", Barnard A., Cambridge: Cambridge University	2000

Evaluation Criteria

Assignments/ Quizzes/ Case Study/ Project/ PPT: 40 marks

Mid Term: 20 marks

End term: 40 marks

Total: 100 marks

Course Name	:	**Appreciation of Art**
Course Code	:	**HS2702**
Credits	:	**3**
L T P	:	**3-0-0**

Course Objective:
The main aim of this course is to introduce the students to explore and interpret the visual art forms and their cultural connections across historical periods.

Total No. of Hours: 42

Lecture wise breakup -**B1**		No. of Hours
1	**Introduction** What is Art and the functions of art?;A review of selected authors' definition and perception of art and possible 're-definitions' of Art.	5 hrs
2	**Art and Society** Identify relationships between art and the society in which and for which it was and is created.	4hrs
3	**Visual communication, literacy, and intelligence.** Defining and understanding the relationships between visual communication, visual literacy, perception, and intelligence.	4 hrs
4	**Art: A language and a tool** Defining and understanding what is required for a language to be effective and to understand its role in effective communication. Create a relationship between languages and art which can be described as a tool or language of communication.	4hrs
5	**The Vocabulary of Art** Acknowledge and apply vocabulary pertinent to the discussion and appreciation of art.	4 hrs
6	**The Visual elements and Principles of Design** Demonstrate an understanding of the Visual elements and Principles of Design.	4hrs
7	**Two-Dimensional Media** In relation to two-dimensional media (like painting, drawing, printing and photography), establish ways in which artists manipulate and organize the visual elements and principles of design to create compositions. Demonstrate an understanding of the technical process of selected art media.	4 hrs
10	**Three-Dimensional Media**	6 hrs

	In relation to three-dimensional media (like Architecture, sculpture, ceramics, and crafts), establish ways in which artists manipulate and organize the visual elements and principles of design to create compositions. Demonstrate an understanding of the technical process of selected art media.	
11	Chitrasutra -Six Limbs of Indian Painting	3 hrs
12	Theory of Rasa and Bhava	4 hrs

Course Outcomes:	
1	The students will be able to appreciate the aesthetic processes involved in the act of artistic production.
2	The students will be able to identify the issues examined by artists in their work.
3	The students will be able to explain the role and effect of the visual arts in different social, historical, and cultural contexts.

Suggested Readings	**Year of Publication/ Reprint**
Text Books	
1. "Living with art", Gilbert, R.,New York: McGraw Hill.	2002
2. "Visual Order-The Nature and Development of Pictorial Representation", Freeman, N.H., Cambridge University Press.	2010

Evaluation Criteria

1. Presentation/quiz/ written assignment)– 50marks
2. End-term written examination – 50 marks

Total – 100 marks

Course Name	**:**	**English Literature**
Course Code	**:**	**HS2703**
Credits	**:**	**3**
L - T - P	**:**	**2-1-0**
Teaching Hours	**:**	**42**

Course Objective:

The aim of the course is to introduce the students to Literature in English; familiarize them with a diverse variety of genres, writing styles, issues and ideas; enhance the ability to read, think, write and speak in a multi-faceted and literary manner; enable them to appreciate literature and expand the horizons of their understanding of ideas, creative expression, human nature, philosophy, culture and intertextuality.

Course Content

2. Books Across Cultures

1 of the books will be covered by the teacher for intensive reading with students in the lectures &1of them will be taken up by the students in consultation withtheteacher for extensive reading as a self-study book.

1.*Oryx & Crake* by Margaret Atwood
2. *I, Robot* by Isaac Asminov
3. *Harry Potter and the Order of the Phoenix* by J K Rowling
4. *Hard Times* Charles Dickens
5. *ThePlague* by Albert Camus

2. Play

1 of the 3 plays to be taken up by the teacher for intensive reading.

1. *Tughlaq* (Translated) by GirishKarnad
2. *The Glass Menagerie* by Tennessee Williams
3. *Look Back in Anger* by John Osborne

3. Short Stories

The students must do 1 short story from one of the given short story collections for extensive reading in consultation with the teacher.

1. *The Interpreter of Maladies* by JumpaLahiri
2. *Hills Like White Elephants*from*Men Without Women* by Ernest Hemingway
3. *The Flints of Memory Lane*(*in Fragile Things)* by Neil Gaiman

4. Poetry/ Lyrical Compositions

5. *Student must do 1 poem/ lyrical compositionfromthe works of the poets/composers in consultation with the teacher.*
   1. *A March in the Ranks Hard-Prest/When Lilacs Last in the Dooryard Bloom'd/ One's Self I Sing*byWalt Whitman
   2. *Suzanne /The Only Poem/* by Leonard Cohen
   3. *On Pain/ On Children* by Khalil Gibran

Course Outcomes:	
1	Acquaintance with Literature in English.
2	Ability to identify, analyse and appreciate a variety of genres, writing styles, issues and ideas.
3	Ability to read, think, write and speak in a multi-faceted and literary manner.
4	The students will learn to appreciate literature.
5	The students will develop an understanding of ideas, creative expression, linguistic expression, human nature, philosophy, culture and intertextuality.

Total No. of Lectures – 28

Lecture-wise Breakup		No. of Lectures
1	Introduction tonovel,author, literary, historical and cultural background of the book	(2)
2	Introduction to theme(s); discussion of all the direct and indirect thematic issues of the book	(2)
3	Discussion of structure, narrative technique and writing style of the book	(2)
4	Discussion of the characterization & plot of the book	(2)
5	Analysis of the book including discussion of the ideas of critics	(2)
6	Literary and cultural impact of the book	(2)
7	Introduction to author, background, structure & narrative technique; discussion of all the direct and indirect thematic issues of short story 1	(2)
8	Introduction to author, background, structure & narrative technique; discussion of all the direct and indirect thematic issues of short story 2	(2)
9	Introduction to literary, historical and cultural background of the play, Discussion of all the direct and indirect thematic issues of the play	(2)
10	Discussion of the characterization & plot of the play	(2)
11	Analysis of the play including discussion of the ideas of critics, Literary and cultural impact of the play	(2)
12	Introduction to the poet, background, form and content of poem 1	(2)
13	Introduction to the poet, background, form and content of poem 2	(2)
14	Introduction to the poet, background, form and content of poem 3	(2)

Total No. of Tutorials – 14

Hours-wise Breakup		No. of tutorials
1	Discussion on the Novel	(4)
2	Discussion on the Play	(4)
3	Discussion on Story 1 and Story 2	(4)
4	Discussion on Poem 1, 2, 3	(2)

S.No.	*Name of Book/ Authors/ Publisher*	*Year of Publication/ Reprint*
	Text Books	
1	An Introduction to Literature, Criticism and Theory, 3rd Edition, B. Andrew and R. Nicolas : Pearson Longman,	2003
2	Beginning Theory: An Introduction to Literary and Cultural Theories 2nd Edition, B.Peter: Manchester: Manchester University Press	2004
	Reference Books	
1	Cultural Studies 1983, H. Stuart and G. Lawrence : A Theoretical History: Durham & London: Duke University Press	2016
2	A Handbook of Critical approaches to Literature, 5th Edition, G.Wilfred , Oxford: OUP	2005

Evaluation Criteria
Assignments (presentation/ quiz/ written assignment etc.)– 40marks
Viva – 10 marks
End-term written examination – 50 marks
Total- 100 marks

Course Name	:	**History**
Course Code	:	**HS2704**
Credits	:	**3**
L T P	:	**3-0-0**

Course Objective:
The main aim of this course is to introduce the students to some of the major events in World History, to enhance their understanding of the events that continue to have a significant impact on the contemporary world.

Total No. of Hours: 42

Lecture wise breakup		No. of Hours
1	**From the Traditional to the Modern - Commercial and Military Revolutions (1760-1800)** The Study of History, The Great Divide, The Traditional and the Modern, The Great Divide-Why?, The World of 1760, The Commercial Revolution, The Military Revolution, Introverts and Extroverts, The Fates of India and North America	(2)
2	**Democratic Revolutions of the Atlantic World (1760-1800)** The Diffusion of Authority, Democratic Revolutions, These United States, Liberty and Common Sense, The French Revolution, The French Republic The World's Revolution	(2)
3	**Revolutionary Wars (1800-1830)** Lucky Americans, Napoleonic Wars, The End of Spanish America, New Republics and Empires in the Americas, The Tipping Point-India, The World of 1830	(2)
4	**The World Transformed (1830-1870)** The Great Divergence-Why?, Engines, Electricity, Evolution, Harnessing the New Forces, The New Situation, The Islamic World Adapts, Breaking Open China and Japan	(2)
5	**The Rise of National Industrial States (1830-1871)** To Build a Nation, The Global and the Local, The Zenith of Liberalism, A Liberal Rainbow, Enemies of Liberalism	(3)
6	**The Rise of National Industrial Empires (1871-1900)** The Age of Imperialism, Tipping Points, Varieties of Imperialism, China in the Balance, The Wave Breaks	(2)

7	**The Great Acceleration (1890-1910)** The Great Acceleration, The Second Industrial Revolution, Modern Capitalism, The Dynamo and the Virgin, Modern Nation-States, Revolutionary Nation-States, Battle Lines, The Battles Begin, The Big Picture	(3)
10	**The Crackup (1905-1917)** The Shock of 1914, Schizophrenic Germany, The Balkan Whirlpool, The Shock of 1914-Second Cut, All the Plans Fail, On to Victory?	(2)
11	**New Orders Emerge (1917-1930)** Total States, Why Did the Allies Win?, The End of Empires?, Communism, Anti-Communism, The Age of Uncertainty, Modern Women, The World of 1930	(3)
12	**The Crisis of the World (1930-1940)** Challenges to Capitalism and Collective Security, Escapes from Freedom, Total Politics, New Wars for New Empires, Triumph of the New Empires	(2)
13	**Total War and Aftermath (1940-1950)** Choosing Global War, Gambling for Victory, Strategies for Total War, Zero Hour, Imagining New Countries, Postwar, Two Europes, Revolutionary Asia	(3)
14	**The Return of Wartime (1950-1968)** The Age of the Americans, Choosing War in Korea, Contemplating World War III, The Shadow of World War III, The Nuclear Revolution, New Empires and Confederations, The Third World, To the Brink,Wars of Containment	(4)
15	**Decay and Renaissance (1968-1991)** Breakdown and Reaction, The Weary Establishment, Bust, New Thinking in the West, Global Capitalism Transformed, New Thinking in the East, The End of the Cold War	(3)
16	**The Next Phase (1991-2013)** The 'Washington Consensus', Toward a New Era in World History, The Great Convergence, The Bottom Billion, The Muslim World, Drift and Shock, The Global and the Local, An Age of Transition	(4)
17	**Late-term Review** Review of all the thinkers studied along with some complementary material.	(5)

Course Outcomes:	
1	The students will be able to learn about some of the major events in World History.
2	The student will be able to analyze current world affairs from multifarious perspectives.

Suggested Sources/ Books:		
S. no.	*Name of Book/ Authors/ Publisher*	*Year of Publication/ Reprint*
	Text Books	
1	'Mastering Modern World History' by Norman Lowe	2015
2	'World History' by Krishna Reddy	2018
	Reference Books	
1	'A History of the Modern World' by Robert Roswell Palmer	2001
2	'A History of the Modern World' by Ranjan Chakravarti	2012

EVALUATION CRITERIA

1. Assignments (Quizzes/ Written Assignments): 50 marks
2. End-term Exam: 50 marks
   Total – 100 marks

Course Name	:	**Introduction to Art History**
Course Code	:	**HS2705**
Credits	:	**3**
L T P	:	**3-0-0**

Course Objective:
The main aim of this course is to introduce the students to some of the major movements in History of Art, to enhance their understanding that continues to have a significant impact on the contemporary world.

Total No. of Hours: 42

Lecture wise breakup		No. of Hours
1	Florence and the Beginning of the Renaissance Renaissance Art Intro to Florence	2
2	Introduction to Classic Art History Greek Classic Art: Things you should know before you study the Renaissance; 13th to 14th C Giotto, Dante and the Arena Chapel; Captioned 13th to 14th C Perspective St Francis Cimabue and Giotto;Transitions into Late Gothic to Proto Renaissance Art; Iconography Pisano Martini Duccio Giotto Lorenzetti	2
3	15th Century Brunelleschi and Florence Cathedral; Donatello David and the Feast of Herod; Early Northern Renaissance Limbourg Bros Van Eyck Metsys; Ghiberti and the Gates of Paradise of Florence Cathedral; Linear Perspective Masaccio and Mantegna; Mantegna and the Camera Picta	3
4	16th Century Leonardo; Women and Art During the Renaissance; The Redesign of St Peters During the Renaissance by Bramante and Michelangelo; Michelangelo and the Sistine Chapel Ceiling; Raphael and the School of Athens; Michelozzo Palazzo Medic Riccardi and Alberti Palazzo Rucellai Architecture; Printmaking The Reformation Durer Cranach and Holbein; Netherlandish Renaissance Art of Bosch; Michelangelo and the Last Judgment; Michelangelo and the Birth of Mannerism in Architecture at San Lorenzo; Mannerism in Painting; Mannerism in Architecture	5
5	17thCentury: Renaissance through Late Baroque The Vatican; Bernini David and St Theresa; The Carracci Farnese Ceiling Self Portrait and Flight to Egypt; Caravaggio; Rembrandt; The Gentileschi; Velasquez; Rubens; Vermeer; Versailles	5
6	18th Century Baroque Art Chardin and Greuze; French Baroque and Rococo Art; 18th C History Painting; William Hogarth; Neoclassical Art; 18th to 19th C Romanticism Part 1	3
7	19th Century Romanticism Part 2 Walpole Ruskin Turner Goya Gericault; Paris Baron Haussmann and Caillebotte; French Academic, Romanticism,	6

	and Orientalism; Linear Perspective; Realism in Part 1 Daumier Courbet; Realism Part 2 Manet; Impressionism Degas and ColorTheory; Impressionism Mary Cassatt; Impressionism Monet; Rodin; Post Impressionism Cezanne; Post Impressionism Seurat; Post Impressionism Gauguin; Technology and Architecture; Vincent van Gogh	
10	20th Century Expressionism Klimt Munch Kirchner; 20th Century Picasso; DADA; Architecture Modernism Bauhaus DeStijl and International; Pollock and Benton; Pop Art Rauschenberg Warhol Oldenburg Johns; Lucian Freud	4
11	Modern Indian Art Form Advent of British Colonial Rule; Company Painting: A new genre in Indian Art; Kalighat Painting: from folk art to urban milieu; Raja Ravi Varma, Amrita Sher-Gil, Jamini Roy: In search of Indian Identity	3
12	Early Modern Indian Sculpture; Nationalism, Rabindranath Tagore and Bengal School; Calcutta- the happening center of modern Indian art; Santiniketan- the alternative modernism Nandalal&BenodeBehari; Santiniketan- the alternative modernism Ramkinkar& Rabindranath	2
13	1940s- a different social reality; Calcutta Groups & Bombay Progressive Artists Group; Post Independent Sculpture; Diversities in Style and Content: 1950 onwards (I) & (II)	2
14	Abstraction in modern Indian art; Neo figuration and the narrative trends; Folk Art and Modernism; Breaking the barriers: Unconventional mediums and ideas; Experiments Innovations: Past and Future	3
15	Indian Miniature Paintings- Rajasthani, Mughal, Pahari Paintings	2

Course Outcomes:		
1	The students will be able to learn about some of the major movements and artists in History of Arts.	
2	The student will be able to recognise the works of art from multifarious perspectives.	
Suggested Sources:		
S. no.	*Name of Course*	Platform
1	Modern Indian Art from Colonial Period to Present https://nptel.ac.in/courses/109/104/109104176/	NPTEL (IIT Kanpur)
2	Art History Renaissance to 20th Century https://www.udemy.com/course/art-history-survey-1300-to-contemporary/	Udemy
3 (Optional)	The Art, Architecture and Design of Ancient India	Udemy

	https://www.udemy.com/course/the-art-architecture-and-design-of-ancient-india/	

Evaluation Criteria

1. Presentation/quiz/ written assignment)– 50marks
2. End-term written examination – 50 marks
   Total- 100 marks

Course Name	:	**Philosophy- an Introduction**
Course Code	:	**HS2706**
Credits	:	**3**
L T P	:	**3-0-0**

Course Objective:
The main aim of this course is to introduce the students to some of the major philosophical ideas, to enhance their understanding of the contemporary world in a philosophical context and to learn to develop philosophical and critical thinking.

Total No. of Hours :42

Lecture wise breakup		No. of Hours
1	**The Milesians & Heraclitus** Introduction to Ancient Philosophy, How We Study the Pre-Socratics, Fragments and Sources, Philosophers or scientists?, The Material Principle, God in Nature?, Heraclitus on the LOGOS, Heraclitus on Change.	(2)
2	**Parmenides to Plato** Parmenides' Prohibition, Parmenides Against Change, Responses to Parmenides, Naturalism after Parmenides, Plato and Socrates, Socrates in the Apology, Piety in the Euthyphro, Morality and Religion	(2)
3	**Plato on Virtue, Teaching, & Justice** Virtue in the Meno, Teachers of Virtue, Theory of Recollection, Was Socrates Teaching?,Meno's Paradox, Knowledge vs. True Belief, Is Justice a Virtue?, The Just City, The Just Soul, Rational Injustice?	(2)
4	**Plato on Reality & Goodness** Plato's Theory of Forms, The Real and the Good, The Creation of the World, The World Soul, Plato's Mathematical Physics	(4)
5	**Rousseau and Kant: Philosophy, Modernity, and Intellectual History** Examination of philosophy as a reflection on modernity and progress through reading Jean-Jacques Rousseau and Immanuel Kant.	(1)
6	**Rousseau's Enlightenment** Using Rousseau's Discourse on the Origins of Inequality to study how the pursuit of knowledge is related to the politics of inequality.	(1)

7	**Karl Marx: From Enlightenment to Revolution** A confrontation with alienation, class struggle and revolution through the study of Karl Marx.	(3)
8	**Modernism and Art for Art's Sake** Examining Flaubert's Madame Bovary as a reflection on convention, stupidity and art in the wake of the failures of mid-19th century revolution.	(3)
9	**Charles Darwin: Re-imagining the World** Situating Charles Darwin's great achievement in the context of the English Enlightenment traditions and reimaging the world without a goal for change.	(1)
10	**Baudelaire and Nietzsche: From Struggle to Intensity** Through an examination of Charles Baudelaire and Friedrich Nietzsche, examining an aesthetic embrace of intensity instead of search for the "really real."	(4)
11	**Philosophy of Modern Paintings** A Quick Survey of how advanced painting moved toward a consideration of the surface of the canvas and away from a quest for the most realistic representation of the world.	(1)
12	**Freud: Sex, Death, Aggression and Guilt** With a focus on Civilization and its Discontents, anexamination of how Freud's theories tried to expose profound instincts as they appeared in daily life.	(1)
13	**Virginia Woolf: Art, Loss, Forgiveness** A reading of Virginia Woolf's modernist novel To the Lighthouse shows how giving up the search for the "really real" can liberate one to attend to the everyday.	(3)
14	**Emerson and Wittgenstein: The Postmodern Everyday** Going back to Ralph Waldo Emerson and forward to Ludwig Wittgenstein to consider how forms of life and language games need to foundation to be compelling.	(3)
15	**Horkheimer and Adorno: From Critical Theory to Postmodernism** Through a consideration of Max Horkheimer& Theodor Adorno along with Michel Foucault, confronting the philosophical effort to escape from totality in order to understand the politics of control.	(3)

16	**Philosophy of Postmodern Paintings** A very brief consideration of how artists are responding to the loss of foundations to produce work that redefines art.	(1)
17	**Butler and Zizek: Postmodern Identities** Examining short pieces by Judith Butler and SlavjoZizek to understand how identities get formed (and performed) in a world without foundations.	(3)
18	**Late-term Review** Review of all the thinkers studied along with some complementary material.	(1)
19	**PostmodernPragmatisms** After postmodern playfulness, or alongside it, identifying the resurgence of the pragmatic impulse to return philosophy to real human problems.	(3)

Course Outcomes:	
1	The students will be able to learn about some of the major philosophical ideas .
2	The students will be able to understand the contemporary world in a philosophical context.
3	The students will develop philosophical and critical thinking.

Suggested Sources/ Books:		
S. no.	*Name of Book/ Authors/ Publisher*	*Year of Publication/ Reprint*
1	Coursera Course 'Ancient Philosophy: Plato and his Predecessors'from the University of Pennsylvania (10 hours)	
2	Coursera Course 'The Modern and the Postmodern (Part 1)' from Wesleyan University (14 hours)	
3	Coursera Course 'The Modern and the Postmodern (Part 2)' from Wesleyan University (18 hours)	

EVALUATION CRITERIA

1. Assignments (Quizzes/ Written Assignments): 50 marks
2. End-term Exam: 50 marks
   Total – 100 marks

Course Name	**:**	**Political Science**
Course Code	**:**	**HS2707**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
The objective of the course is to make undergraduate engineering students understand the role of theory in social sciences and to understand basic aspects of Political Sciences and how it will effect society at large.

Total No. of Lectures – 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Political Science** Political Science: Meaning, Definition and Scope. Relationship of Political Science with Economics, History and Sociology.	**(2)**
2	**The State** The State: Definition, Elements and its Distinction from Government and Society. The Role of State in the Era of Globalisation. Theories of the origin of State: Social Contract, Historical/Evolutionary.	**(2)**
3	**Power, Grassroot Democracy** Power, Authority, Legitimacy: Meaning and Characteristics. Women, Power and Politics, The Panchayats and Municipalities. Democratic Decentralisation- Local Self-Governance: Rural and Urban. Green Governance: Sustainable Human Development	**(3)**
4	**Rights and Duties** Rights and Duties: Meaning, Types and Co-relation between two. Universal Declaration of Human Rights: Meaning of Human Rights, Nature and Characteristics. Fundamental Rights (Art 14- Art 32)- Meaning, Explanation, Criticism & Importance. Fundamental Duties- Meaning, Explanation, Evaluation, Criticism & Importance.	**(3)**
5	**Liberty, Equality and Justice** Liberty: Meaning, Types & its Safeguards. Equality: Meaning, Types and Relationship between Liberty and Equality.	**(2)**

	Justice: Meaning and its Dimensions.	
6	**President, Parliament, Prime Minister, Governor and Chief Minister and Council of Ministers** President: Election, powers, position and changing role. Parliament: Composition, power and role. Prime Minister: Election, powers, position and changing role. Governor: Appointment, power and role. Chief Minister: Election, power, position, role and Council of Ministers.	**(4)**
7	**Judiciary** High Court: Composition, powers and role. Supreme Court: Composition, powers and Judicial Review.	**(2)**
8	**Political Parties and its Nature,** Nature of Party system in India: A critical evaluation. National Political Parties: Indian National Congress, BJP, CPI, CPI(M), BSP and their ideology, policy and programmes. Regional Political Parties: SAD, DMK, AIDMK and their Ideology, policy and programmes.	**(3)**
9	**The Election Commission and Role of Caste, Religion in Indian Politics.** The Election Commission: A critical evaluation and electoral reforms in India. Voting Behaviour in India- its Determinants. Role of Caste, Untouchability and Critique of Hindu Social order, Religion in Indian Politics and Regionalism in Indian Politics-its causes and impact. Religion and Politics Debates on Secularism and Communalism.	**(4)**
10	**Comparative Political System of U.K and U.S.A and International Politics.** The British Political System- Salient Features and Conventions. The Constitutional framework of U.S- Salient Features, Separation of Powers & Check & Balances. Meaning, Nature and Scope of International Politics. Role of International Organisations- WTO, IMF, and WHO	**(3)**

Tutorials- 14 Hours

Hour wise breakup of Tutorials		**No. of Hours 14**
	Practical work	**(14)**

	Course Outcome
1	The students will be able to understand how Political Science affects citizens of the country.
3	The students will learn about political structures and how it shapes and influences politics of nations.

S.No.	**Suggested Books :**	**Year**
	Text Books	
1	"The Oxford Handbook of the Indian Constitution", Choudhry, Khosla and Mehta, London : Oxford University Press.	2016
2	"The Nature of Political Theory", Vincent, A.,New York: Oxford University Press.	2004
	Reference Books	
1	"What is Political Theory", in Bhargava, R and Acharya, A. (eds.) Political Theory: An Introduction. New Delhi: Pearson Longman.	2008
2	"Judicial Review Versus Parliamentary Sovereignty', in Explaining Indian Institutions: A Fifty Year Perspective, 1956-2006: Volume 2: The Realm of Institutions: State Formation and Institutional Change ", L. Rudolph and S. Rudolph, New Delhi: Oxford University Press.	2008

Evaluation Criteria

Assignments/ Quizzes/ Case Study/ Project/ PPT: 40 marks

Mid Term: 20 marks

End term: 40 marks

Total: 100 marks

Course Name	**:**	**Public Administration**
Course Code	**:**	**HS2708**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
The objective of the course is to make undergraduate engineering students understand the role of theory in social sciences and to understand basic aspects of Public Administrationand its role in country's governance.

Total No. of Lectures-28

Lecture wise Breakup		**No. of Lectures**
1	**Introduction to Public Administration** Meaning, Nature, Scope and Significance of Public Administration; Public and Private Administration; Public Administration as a Science or an Art; Relationship of Public Administration with other Social Sciences.	2
2	**Formal and Informal Organisation** Organisation: Meaning, Types: Formal and Informal Organisation Forms of Organisation: Hierarchy, Span of Control; Unity of Command, Authority and Responsibility	2
3	**Centralisation and Decentralisation** Difference of Power in term of Centralisation and Decentralisation Decision Making: Meaning, types and process.	2
4	**Coordination, Communication, Supervision and Leadership** Coordination: Concept, Method and Hindrances. Communication: Concept, Process and Barriers. Supervision: Concept and Methods. Leadership: Concept, Style, Qualities of a Good Administrator.	3
5	**Features of Indian Administrator** Union Executive: President; Prime Minister and Council of Ministers. Union Legislature: LokSabha its Composition, Function and Role, RajyaSabha- Composition, Function and Role.	3

6	**State Executive** Governor, Chief Minister and State Council of Ministers. State Legislature: Legislative Assembly and Legislative Council- Composition, Function and Role. Centre- State Relations: Administrative and Legislative.	3
7	**Judiciary and Bureaucracy** Union and State Judiciary: Supreme Court- Composition, Function and Role. High Court- Composition, Function and Role. Bureaucracy: Meaning, Features and Role. Position and Rank Classification System: Significance and Features.	3
8	**Recruitment System in India and Audit** Audit: Concept, Objectives and Types. Comptroller and Auditor General of India (CAGI): Appointment, Functions and Role. Recruitment: Meaning, Method and Process. Recruitment System of Higher Civil Services in India. UPSC: Composition, Function and Role.	3
9	**Financial Administration and Union Ministry of Finance.** Financial Administration: Meaning and Significance. Aspects of Public Finance. Budget: Meaning, Types and Principles. Budget: Preparation and Enactment. Union Ministry of Finance: Organisation, Function and Role. Centre-State Financial Relations. Union Finance Commission: Composition and Functions.	3
10	**Local Government** Meaning and Significance of Local Government. Role of Deputy Commissioner; Divisional Commissioner The 73rd Constitutional Amendment Act- Provisions and its Impact and Panchayati Raj Institution in Punjab- Structure, Functions, Sources of Finances and Personal. The 74th Constitutional Amendment- Provision and its Impact. Urban Local Bodies: Structure, Functions and Source of Finance. Mayor: Position, Function and Powers. Rural-Urban Relationship Challenges and Remedies.	4

Tutorials- 14 Hours

Hours wise Breakup		**No. of Hours 14**
	Practical work based on Lectures	

Course Outcomes:	1. The students will learn about political structures and how it shapes and influences politics of nations. 2. The students will be able to understand the structure of various bodies for Public Administration. 3. The students will be exposed to process of country's governance.

Suggested Books:		
S. No.	**Name of Book/ Author/ Publisher**	**Year of Publication/Reprint**
	Text Books	
1	"Development Administration in India ,Mahajan, Sage Publications.	2019
2	"Public Administration: Concepts and Theories", Basu, New Delhi: Sterling Publishers.	2008
	Reference Books	
1	"Public Administration: Issues and Perspective", Bhattacharya, New Delhi: Jawahar Publishers and Distributors.	2012
2	"Encyclopaedias of Disaster Management", Goel, S.L., New Delhi : Deep & Deep.	2005

Evaluation Criteria

Assignments/ Quizzes/ Case Study/ Project/ PPT: 40 marks

Mid Term: 20 marks

End term: 40 marks

Total: 100 marks

Course Name	**:**	**Pattern Recognition**
Course Code	**:**	**CS2701**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – III (DEC-III) AI&ML**

Course Objectives:
Student should learn the fundamental algorithms for pattern recognition and investigate the various classification and clustering techniques.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**BASICS OF PROBABILITY, RANDOM PROCESSES AND LINEAR ALGEBRA** Probability: independence of events, Conditional and joint probability, Bayes' theorem; Random Processes: Stationary and nonstationary processes, Expectation, Autocorrelation, Cross-Correlation, Spectra, Linear Algebra: Inner product, outer product, Inverses, Eigen values, Eigen vectors, Bayes Decision theory	**6**
2	**BAYES DECISION THEORY** Minimum-error-rate classification, Classifiers, Discriminant functions, Decision surfaces, Normal density and discriminant functions, Discrete features	**5**
3	**PARAMETER ESTIMATION METHODS** Maximum-Likelihood estimation, Gaussian case, Maximum a Posteriori estimation, Bayesian estimation, Gaussian case	**5**
4	**UNSUPERVISED LEARNING AND CLUSTERING** Criterion functions for clustering, Algorithms for clustering, K-Means, Hierarchical and other methods, Cluster validation, Gaussian mixture models, Expectation-Maximization method for parameter estimation, Maximum entropy estimation	**7**
5	**SEQUENTIAL PATTERN RECOGNITION** Hidden Markov Models (HMMs), Discrete HMMs, Continuous HMMs	**4**
6	**NONPARAMETRIC TECHNIQUES FOR DENSITY ESTIMATION** Parzen-window method, K-Nearest Neighbour method	**4**
7	**DIMENSIONALITY REDUCTION** Fisher discriminant analysis, Principal component analysis, Factor analysis	**4**
8	**LINEAR DISCRIMINANT FUNCTIONS** Gradient descent procedures, Perceptron, Support vector machines	**4**
9	**NON-METRIC METHODS FOR PATTERN CLASSIFICATION** Non-numeric data or nominal data, Decision trees: CART	**3**

List of Experiments:		Number of Turns
1	Generating features for different classes and analyzing them	**2**
2	Building classifier for multiple classes using Bayes's rule	**2**
3	Implement Nonparametric techniques for density estimation	**2**
4	Implement dimensionality reduction and linear discriminant functions for feature extraction	**2**
5	Implementation of clustering of patterns	**2**
6	Implement Sequential Pattern Recognition	**2**
7	Implement Non-metric methods for pattern classification	**2**

Course Outcomes: At the end of the course, students will be able to:	
1	Describe and compare a variety of pattern classification, structural pattern recognition, and pattern classifier combination techniques
2	Apply pattern recognition techniques to real-world problems such as document analysis and recognition
3	Summarize, analyse and relate research in the pattern recognition area verbally and in writing

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Pattern Classification, Richard O. Duda, Peter E. Hart, David G. Stork John Wiley	2001
2	Pattern Recognition, Konstantinos Koutroumbas and Sergios Theodoridis 4th Edition., Academic Press	2009
3	Pattern Recognition and Machine Learning, **Bishop**, Christopher, Springer	2006

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Course Name	**:**	**DEEP LEARNING**
Course Code	**:**	**CS2702/CS4701 (DEC-III / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – III (DEC-III) AI&ML**

Course Objectives:
To introduce the fundamentals of deep learning and the main research activities in this field. To learn architectures and optimization methods for deep neural network training

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1	**LINEAR ALGEBRA REVIEW AND OPTIMIZATION:** Brief review of concepts from Linear Algebra, Types of errors, bias-variance trade-off, overfitting-underfitting, brief review of concepts from Vector Calculus and optimization, variants of gradient descent, momentum.	4
2	**LOGISTIC REGRESSION:** Basic concepts of regression and classification problems, linear models addressing regression and classification, maximum likelihood, logistic regression classifiers.	2
3	**NEURAL NETWORKS:** Basic concepts of artificial neurons, single and multi-layer perceptrons, perceptron learning algorithm, its convergence proof, different activation functions, softmax cross entropy loss function.	6
4	**CONVNETS:** Basic concepts of Convolutional Neural Networks starting from filtering. Convolution and pooling operation and arithmetic of these, Discussions on famous convnet architectures - AlexNet, ZFNet, VGG, GoogLeNet, ResNet, MobileNet-v1	8
5	**REGULARIZATION, BATCHNORM:** Discussion on regularization, Dropout, Batchnorm, Discussion on detection as classification, region proposals, RCNN architectures	8
6	**RECURRENT NEURAL NETWORKS:** Basic concepts of Recurrent Neural Networks (RNNs), backpropagation through time, Long-Short Term Memory (LSTM) architectures, the problem of exploding and vanishing gradients, and basics of word embedding,	8

7	**Autoencoders:** Autoencoders, Denoising autoencoders, sparse autoencoders, contractive autoencoders	6

Suggested References:

1. Ian Goodfellow, YoshuaBengio, Aaron Courville. Deep Learning, the MIT press, 2016
2. Bengio, Yoshua. " Learning deep architectures for AI." Foundations and trends in Machine Learning 2.1, Now Publishers, 2009

Course Outcomes: After completion of course, students would be able to:

1. Understand the fundamentals of deep learning
2. Compare various deep neural network architectures
3. Apply various deep learning algorithms based on real-world applications.

Lab Assignments:

S. No.	Experiment	No. of Turns
1.	Introduction to python libraries for deep learning: Keras, Tensorflow, Theano, OpenCV	2
2.	Implementation of MultiLayer Perceptron(MLP)	2
3.	Implementation Basic CNN model and various CNN architectures - transfer learning	2
4.	Implementation of Recurrent neural networks	2
5.	Deep Learning based project	4

Course Name	**:**	**Network Administration and Management**
Course Code	**:**	**CS2703**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – III (DEC-III) NSS**

Course Objectives:

Students should be able to

- Understand and apply the principles of network administration and management
- Outline the principles of network management architecture and apply them to design network management systems based on standard architectures.
- Understand the network management overview, fundamental concepts of computer network technology and have a basic knowledge of the various network models and their uses.
- Understand the basic foundations of network management.
- Understand and analyze simple network management protocols
- Independently study literature concerning network management tools, systems and applications.

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1.	**Network Management Overview** Data and telecommunication networks, Distributed computing environments, TCP/IP based networks, communication protocols and standards, case histories of networking and management, challenges of IT Managers, Network management: Goals, organization and functions	4
2.	**Review of Computer Network Technology** Network topology, Local area networks, network node components, wide area networks, transmission technology, Integrated services	4
3.	**Basic foundations: standards, models and language** Network management standards, network management model, organization model, information model, communication model, ASN.1, encoding structure, functional model	4
4.	**SNMP Management** Organization and information models, communication and functional models, Major challenges, system architecture, management information base, protocol, Documentation architecture, applications, management information base, security, RMON	10
5.	**Telecommunication management network** Operations systems, conceptual model, standards, architecture, implementations issues	5
6.	**Management tools, systems and applications**	10

	Network management tools, network statistics measurement systems, commercial network management systems, system management, enterprise management solutions, network management applications	
7.	**Technologies and trends in network management** Web based management, Cloud network management, standards and protocols, cloud based IOT management, management in edge computing	5

List of experiments:		**No. of Turns**
1.	Understanding and using of commands for network management	3
2.	Practical based network management simulation	5
3.	Practical based on Wireshark	6

Course Outcomes:	
At the end of the course, students will be able to:	
1.	Independently understand basic computer network technology.
2.	Understand and explain the network management overview
3.	Understand the basic foundations of network management
4.	Understand and analyse simple network management protocols
5.	Use network management tools, systems and applications

Suggested Books:

Sr. No.	**Name of books / Author/ Publisher**	**Year of Publication/ Reprint**
1.	M. Subramaniam, "Network Management – Principles and practice" 2nd ed PHI	2010
2.	James F. Kurose and Keith W. Ross, "Computer Networking: A top down approach", Pearson Education, 6th edition.	2017
3.	Douglas Comer, "Automated network management systems current and future capabilities," Pearson Prentice-Hall	2007
4.	Adrian Farrel, "Network management know it all," Morgan Kaufmann	2009
5.	Jianguo Ding, "Advances in network management," CRC Press	2010
6.	William Stallings, "SNMP, SNMPv2, SNMPv3, and RMON 1 and 2," Addison-Wesley	2005
7.	B.A. Forouzan, "TCP/IP Protocol Suite", TMH.	2010
8.	A.S. Tanenbaum, "Computer Networks", 5th Edition, PHI	2010
9.	G. Keiser, "Local Area Networks", 2nd Edition, TMH	2002
10.	William Stallings, "Data & Computer Communication", PHI, 10th Edition	2013
11.	B.A. Forouzan, "Data communications and networking", TMH, 5th Edition	2012
12.	B.A. Forouzan, "Local Area Networks", TMH.	2002

Course Name	**:**	**Mobile and Wireless Network Security**
Course Code	**:**	**CS2704/CS4702 (DEC-III / Major Specialization)**
Credits	**:**	
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – III (DEC-III) NSS**

Course Objectives:
The main objective of this course is to analyze cutting-edge research and security solutions in wireless and mobile networks including security in next generation mobile networks.

Total No. Lectures: 42

Sr. No.	**Course contents**	**No. of Lectures**
1.	Security in the digital age, Threats and risks to telecommunications systems, Vulnerabilities from wireline vulnerabilities to vulnerabilities in watermarking wireless communications	3
2.	Fundamental Security Mechanisms, Secure communication protocols and VPN implementation, Multimedia Content watermarking using Robust watermarking and challenge for the information society	6
3.	Wi-Fi security Dedicated architectures - Hot spot architecture, Wireless intrusion detection system (WIDS), Wireless honeypots, Wi-Fi Security-Attacks on wireless networks, security in the IEEE 802.11 standard, Authentication in wireless networks	7
4.	Security in Mobile Telecommunication Networks (Security Standards) in current Wireless & Mobile Systems: WiFi Security (WEP, WPA, WPA-Enterprise); Cellular Security (GSM, 3G, LTE, 5G); Internet of Things / Wireless Sensor Networks / RFID	6
5.	Distinction between wired and wireless networks from source authentication of transmissions, and non-repudiation; Power management and selfishness issues, attacks in wireless networks; DoS and DDoS attacks, reaction to attacks, information processing for sensor networks	7
6.	Wired/wireless networks; Effect of mobility on networks and systems; impact on IP stack from MAC layer and up; ad-hoc and sensor networks; wireless broadcast, IP broadcast, Satellite broadcast; issues of information capacity; information theory	7
7.	Routing in wireless networks, Design of secure protocols: Key distribution for access control	6

Lab Work:

Sr. No	**Lab contents**	**No. of Hours**

.		
1.	Attacks and Security Mechanisms in Wi-Fi and Mobile Networks.	2
2.	Implementing secure information exchange using watermarking of multimedia content.	3
3.	Implementation of Mobile location and navigation security and privacy.	3
4.	Development of novel secure platforms/services using mobile technologies (e.g., secure device-to-device communication in hybrid mobile systems).	3
5.	Implement technique for intrusion detection in wireless networks.	3

Course Outcomes:

At the end of the course, students will be able to:	
1.	Architect a secure wireless network infrastructure for their organization, including strong encryption and centralized authentication.
2.	Gain insight to the hackers threats and the major techniques used against hacking wireless networks.
3.	Master hacking and vulnerability assessment tools to assess the security of wireless networks, including cracking WEP and WPA security.
4.	Identify (and fix) vulnerabilities and mis-configurations in wireless network Technologies

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Wireless and Mobile Network Security, HakimaChaouchi and Maryline Laurent-Maknavicius, Wiley-ISTE.	2009
2.	Mobile and Wireless Network Security and Privacy, Springer	2007
3.	Wireless And Mobile Network Security, PallapaVenkataram and Satish Babu B., McGraw-Hill Education Ltd.	2012
4.	Mobile and Wireless Network Security and Privacy, S. Kami Makki, Peter Reiher, Kia Makki, Niki Pissinou, ShamilaMakki, Springer.	2007
5.	Security and Privacy in Mobile and Wireless Networking, Stefanos Gritzalis, Tom Karygiannis, CharalabosSkianis, Troubador Pub.	2009

Available MOOCS:

1. https://www.coursera.org/learn/wireless-communication-technologies

2. https://www.teracomtraining.com/online-courses-certification/teracom-overview-l2106.htm

Course Name	**:**	**DISTRIBUTED ALGORITHM DESIGN**
Course Code	**:**	**CS2705/CS4703 (DEC-III / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – III (DEC-III) CIS**

Course Objective:

- To expose students to both the abstraction and details of file systems.
- To provide students with contemporary knowledge in parallel and distributed computing.
- To focus on performance and flexibility issues related to systems design decisions.
- Introduce a variety of methodologies and approaches for reasoning about concurrent and distributed programs

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**INTRODUCTION TO DISTRIBUTED SYSTEMS** Review of Networks, Operating Systems – Concurrent Programming - Characteristics & Properties of DSs – Taxonomy - Design goals – Transparency Issues **DISTRIBUTED COMPUTING PARADIGMS** Basic Message Passing Model – The Client Server, Message Passing, Remote Procedure Call Model – RPC in conventional languages and in Java - The Distributed Objects – The Collaborative Application	**6**
2	**INTER-PROCESS COMMUNICATION MECHANISMS** Communication in Distributed Systems, Socket Programming -Client Server examples, I/O Multiplexing, Inetd Super Server – Secure Sockets – The SSL & the Java Secure Socket Extension	**8**
3	**PROCESS MODELS IN DISTRIBUTED SYSTEMS** Processes, Threads - Code Migration; Software Agents – CSP Distributed Processes - Naming with Mobile Entities - Unreferenced Objects	**8**
4	**SYNCHRONIZATION, CONSISTENCY AND REPLICATION** Clock Synchronization – Logical clocks – Election Algorithms – Distributed Mutual Exclusion CONSISTENCY AND REPLICATION: Motivation, Object Replication, Consistency Models, Distribution Protocols – Consistency Protocols	8
5	**FAULT TOLERANCE** Failure Models – Process Resilience – Reliable Client Server and Group Communications – Distributed Commit Protocols – Check-pointing and Recovery - Distributed Databases - Distributed Transactions **DISTRIBUTED FILE SYSTEMS** SUN NFS – Naming issues in DFS – Examples of contemporary DFSes – Comparisons	8
6	**MISCELLANEOUS TOPICS**	4

	Distributed Object-based Systems – COM – CORBA – Architecture and Programming – Distributed Coordination based systems – TIB/RENDEZVOUS – JINI	

Total no. of turns: 14

List of Experiments:		**Number of turns**
1	Implementation of the distributed applications/miniprojects using the TCP/IP Socket API as specified in the class e.g. a typical WWW server, a distributed Readers-Writers problem etc.	7
2	Implementation of the distributed applications/ miniprojects using the SUN ONC RPC Model, JAVA RMI, any Java-CORBA ORBas specified in the class	7

Course Outcomes: At the end of the course, students will be able to:	
1	Understand the concepts and issues related to distributed systems.
2	Design and develop the programs for distributed environment.
3	Manage performance, reliability and other issues while designing in distributed environment.

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of publication**
1	A S Tanenbaum, Martin Steen,"Distributed Systems: Principles and Paradigms", 2/E,PHI	2006
2	Nancy A. Lynch, "Distributed Algorithms", Morgan Kaufmann	1996
3	W Richard Stevens, "Unix Network Programming: Vol 1, Networking APIS: Sockets & XTI",2/E, Pearson Education	1998
4	Colouris,Dollimore,Kindberg, "Distributed Systems Concepts & Design", 4/E,Pearson Ed.	2005
5	MukeshSinghal, Niranjan G. Shivaratri, "Advanced concepts in operating systems: distributed, database, and multiprocessor operating systems", MGH, 1/E	1994

Course Name	**:**	**Agile Software Development and Modern Practices**
Course Code	**:**	**CS2706**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – III (DEC-III) CIS**

Course Objectives:

- In software problem areas that require exploratory development efforts, those with complex requirements and high levels of change, agile software development practices are highly effective when deployed in a collaborative, people-centered organizational culture.
- This course examines agile methods, including Extreme Programming (XP), Scrum, Lean, Crystal, Dynamic Systems Development Method and Feature-Driven Development to understand how rapid realization of software occurs most effectively.

Course Contents: **Total No. Lectures: 42**

Sr. No.	Course contents	No. of Lectures
1	**Agile Processes:** Lean Production – SCRUM, Crystal, Feature Driven Development- Adaptive Software Development – Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.	11
2	**Agility and Knowledge Management:** Agile Information Systems – Agile Decision Making – EarlS Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment	11
3	**Leveraging – KM in Software Engineering** – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).	10
4	**Agile Product Development** – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance – Test Driven Development -Agile Approach in Global Software Development.	10

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1	Understand the background and driving forces for taking an Agile Approach to Software Development.	4
2	Understand the business value of adopting agile approach.	3
3	Understand agile development practices and its practical implementation and how its different from classical approach	3
4	Apply Design principle and Refactoring to achieve agility	4

Course Outcomes:

At the end of the course, students will be able to:	
1.	Realize the importance of interacting with business stakeholders in determining the requirements for a software system

2.	Perform iterative software development processes: how to plan them, how to execute them.
3.	Point out the impact of social aspects on software development success.
4.	Develop techniques and tools for improving team collaboration and software quality.
5	Perform Software process improvement as an ongoing task for development teams.
6	Show how agile approaches can be scaled up to the enterprise level.

Bibliography:

Sr. No.	Book Detail	Year of Publication
1	David J. Anderson and Eli Schragenheim, Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall	2019
2	Hazza and Dubinsky, Agile Software Engineering, Series: Undergraduate Topics in Computer Science, Springer	2019

Course Name	**:**	**Advances of Intelligent and Learning Agents**
Course Code	**:**	**CS2707**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – IV (DEC-IV) AI&ML**

Course Objectives:
Students should accustom students to the state-of-the-art in designing and deploying intelligent and learning agents and to engage students in targeted research and system-building projects.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Models and algorithms for rational, Goal-oriented behavior in agents: Reactive agents, Reinforcement learning, Exploration-exploitation tradeoff, AI planning methods	**6**
2	**MULTI-AGENT SYSTEMS** Multi-agent planning, Coordination techniques for multi-agent systems, Distributed algorithms for constraint satisfaction, Models of competitive behaviour: Game theory mechanism and design	**7**
3	**MULTI-ARMED BANDITS** Coin-tossing game; Definition of stochastic multi-armed bandit, ε-first and ε-greedy algorithms, Definition of regret, Achieving sublinear regret with GLIE sampling, Lai and Robbins's lower bound on regret, UCB, KL-UCB	**8**
4	**MARKOV DECISION PROBLEM** Definition of Markov Decision Problem, policy and value function, Existence of optimal policy, MDP planning problem, Applications of MDPs, Bellman's equations, Action value function, Banach's Fixed-point Theorem, Bellman optimality operator, Proof of contraction under max norm	**8**
5	**Evolutionary Computation** The Reinforcement Learning problem, applications, Prediction and control problems; Ergodic MDPs; Model-based algorithm for acting optimally in the limit; Monte Carlo methods for prediction, Maximum likelihood estimates and least squares estimates.	**8**
6	**Case Studies** Humanoid robot soccer	**5**

List of Experiments:	**Number of Turns**

1	Implement coordination techniques for multi-agent systems	**1**
2	Implement distributed algorithms for constraint satisfaction	**2**
3	Implement ε-first and ε-greedy algorithms	**2**
4	Implement Markov decision process	**2**
5	Implement Reinforcement Learning on prediction problems	**3**
6	Implement Monte Carlo methods for prediction	**2**

Course Outcomes: At the end of the course, students will be able to:	
1	Understand basic concepts, methods, techniques, and tools for the use of intelligent agents in computer-based systems.
2	Apply the principles and methods of intelligent agents to a small-scale practical problem within the framework of a term project
3	Critically evaluate current trends in intelligent agents and their manifestation in business and industry

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Michael Wooldridge: An Introduction to MultiAgent Systems (2nd ed.). Wiley	2009
2	Stuart Russell and Peter Norvig: Artificial Intelligence: A Modern Approach (3rd ed.)	2009
3	Regret Analysis of Stochastic and Nonstochastic Multi-armed Bandit Problems, Sébastien Bubeck and Nicolò Cesa-Bianchi, Foundations and Trends in Machine Learning, Volume 5, Number 1 (Online version)	2012
4	Algorithms for Reinforcement Learning, Csaba Szepesvári, Morgan & Claypool	2009

Course Name	**:**	**ADVANCED ARTIFICIAL INTELLIGENCE**
Course Code	**:**	**CS2708/CS4704 (DEC-IV / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – IV (DEC-IV) AI&ML**

Course Objective:
• To cover modern paradigms of AI that go beyond traditional learning

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**Introduction:** Introduction to AI, expert systems, Utility theory, utility functions	5
2	**Making Decisions:** Decision networks, sequential decision problems, Partially Observable MDPs, Game Theory	9
3	**Reinforcement Learning:** Passive RL, Active RL, Generalization in RL, Policy Search	7
4	**Probabilistic Reasoning over time:** Hidden Markov Models, Kalman Filters	7
5	**Knowledge Representation:** Ontological engineering, Situation Calculus, semantic networks, description logic	6
6	**Planning:** Planning with state space search, Partial-Order Planning, Planning Graphs, Planning with Propositional Logic, hierarchical task network planning, non-deterministic domains, conditional planning, continuous planning, multi-agent planning	8

Total no. of turns: 14

List of Experiments:		**Number of turns**
1	Implement various decision making algorithms	5
2	Implement various Reinforcement Learning approach	2
3	Implement Hidden Markov Models	2
4	Implement various knowledge representation mechanisms	2
5	Implement various planning methodologies	3

Course Outcomes: At the end of the course, students will be able to:	
1	Develop an understanding of modern concepts in AI and where they can be used
2	Design, implement and apply novel AI techniques based on emerging real-world requirements

Sr. No.	Name of Book/ Authors/ Publisher	Year of publication
1	S. RUSSEL, P. NORVIG, Artificial Intelligence: A Modern Approach, Pearson, 3rd Edition.	2015
2	E. RICH, K. KNIGHT, S. B. NAIR, Artificial Intelligence, McGraw Hill Education, 3rd Edition	2017
3	R.S. SUTTON, A.G. BARTO, Reinforcement Learning: An Introduction, The MIT Press, 2nd Edition	2015

Course Name	**WIRELESS SENSOR NETWORKS**
Course Code	**CS2709/CS4705 (DEC-IV / Major Specialization)**
Credits	**4**
L T P	**3 0 2**
Type of Course	**Department Elective Course – IV (DEC-IV) NSS**

Course Objectives:
The students should be able to have an understanding of the fundamental concepts of wireless sensor networks and have a basic knowledge of the various protocols at various layers. They should learn the architecture of the sensor node and various operating systems used for sensor network design. They should learn to apply sensor network protocols, mechanisms, and algorithms to implement sensing systems.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Motivation for a Network of Wireless Sensor Nodes – Definitions and Background, Challenges and constraints; Applications of wireless sensor networks.	**3**
2	**NODE ARCHITECTURE** The Sensing Subsystem - Analog-to-Digital Converter; The Processor Subsystem, Communication Interfaces, Prototypes.	**3**
3	**OPERATING SYSTEMS** Functional Aspects, Nonfunctional Aspects, Prototypes	**4**
4	**PHYSICAL LAYER** Basic Components, Source Encoding, Channel Encoding, Modulation, Signal Propagation	**4**
5	**MEDIUM ACCESS CONTROL** Overview, Wireless MAC Protocols, Characteristics of MAC Protocols in Sensor Networks, Contention-Free MAC Protocols, Contention-Based MAC Protocols, Hybrid MAC Protocols	**4**
6	**NETWORK LAYER** Overview, Routing Metrics, Flooding and Gossiping, Data-Centric Routing, Proactive Routing, On-Demand Routing, Hierarchical Routing, Location-Based Routing, QoS-Based Routing Protocols	**4**
7	**TRANSPORT LAYER** Traditional Transport Control Protocols, Transport Protocol Design Issues, Examples of Existing Transport Control Protocols, Performance of Transport Control Protocols	**4**
8	**POWER MANAGEMENT** Local Power Management Aspects, Dynamic Power Management, Conceptual Architecture	**4**

9	**TIME SYNCHRONIZATION** Clocks and the Synchronization Problem, Time Synchronization in Wireless Sensor Networks, Basics of Time Synchronization, Time Synchronization Protocols	**4**
10	**LOCALIZATION** Overview, Ranging Techniques, Range-Based Localization, Range-Free Localization, Event-Driven Localization	**4**
11	**SENSOR NETWORK PROGRAMMING** Challenges in Sensor Network Programming, Node-Centric Programming, Macroprogramming, Dynamic Reprogramming, Sensor Network Simulators	**4**

List of Experiments:		Number of Turns
1	Implement simulation experiments and projects based on MAC layer of wireless sensor network	3
2	Implement simulation experiments and projects based on network layer of wireless sensor network	3
3	Implement simulation experiments and projects based on transport layer of wireless sensor network	3
4	Implement simulation experiments and projects based on application layer of wireless sensor network	4

Course Outcomes: At the end of the course, students will be able to:	
1	Describe and explain radio standards and communication protocols for wireless sensor networks.
2	Explain the function of the node architecture and use of sensors for various applications.
3	Explain operating systems and programming languages for wireless sensor nodes.
4	Be familiar with architectures, functions and performance of wireless sensor networks systems and platforms.
5	Describe and analyze the specific requirements for applications in wireless sensor networks regarding energy supply, memory, processing and transmission capacity.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	W. Dargie and C. Poellabauer, “Fundemntals of Wireless Sensor Networks – Theory and Practice”, Wiley.	2010
2	KazemSohraby, Daniel Minoli and TaiebZnati, “wireless sensor networks - Technology, Protocols, and Applications”, Wiley Interscience.	2007
3	Takahiro Hara,Vladimir I. Zadorozhny, and Erik Buchmann, “Wireless Sensor Network Technologies for the Information Explosion Era”, springer.	2010

4	Edgar H. Callaway, “Wireless Sensor Networks: Architectures and Protocols”, CRC press.	2003
5	C. S. Raghavendra, Krishna M. Sivalingam and TaiebZnati, “Wireless sensor networks”, kluwer academic publishers.	2004
6	Feng Zhao and Leonidas J. Guibas, “Wireless Sensor Networks:An Information Processing Approach”, Elsevier.	2004
7	Robert Faludi, “Building Wireless Sensor Networks”, O’Reilly.	2010
8	8 Holger Karl and Andreas Willig, “Protocols and Architectures for Wireless Sensor Networks”, John wiley and sons.	2005
9	9 Rajeev Shorey, A. Ananda, MunChoon Chan and Wei Tsang Ooi, “Mobile, wireless, and Sensor networks - technology, applications, and future directions”, IEEE press and wiley interscience.	2003

Course Name	**:**	**MOBILE COMPUTING**
Course Code	**:**	**CS2710**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – IV (DEC-IV) NSS**

Course Objectives:

The students should be able to understand the concepts and principles of mobile computing. They should explore both theoretical and practical issues of mobile computing. They should develop skills of finding solutions for mobile computing applications

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**UNDERSTAND MOBILE PHONES** Mobile Phones -- The New Platform for People-Centric Sensing, Social and Personal Applications , Localization, Exploiting Mobility , Location Privacy	**8**
2	**MOBILE TECHNOLOGIES** Anatomy of a Mobile Device, Survey of Mobile Devices, Applications of Mobile Computing	**4**
3	**WIRELESS COMMUNICATION TECHNOLOGIES** Cellular networks, Wireless (802.11), TCP/IP in the mobile setting, Geolocation and GPS	**6**
4	**APPLICATION DESIGN** Context, Information Architecture, Design Elements, Mobile Web vs Native Applications	**6**
5	**SENSORS ON MOBILE PHONES** Function of sensors: Accelerometer, GPS, Gyroscope, Magnetometer, Luxmeter, Microphone, Proximity Sensor	**6**
6	**DEVELOPMENT ENVIRONMENTS** Introduction to Objective-C, The Model-View-Controller Model, The Delegate Pattern, The iPhone, Android, & Blackberry SDKs, The Application Environment, Limited Resource Computing, Memory Management, Low Power Computing, Fault Tolerance and Persistence, Security Issues	**12**

List of Experiments:		**Number of Turns**
1	Getting familiar with Mobile OS (Android platform considered here) and its Integrated Development Environment. Create single screen/activity application demonstrating the use of: Layouts, Widgets, and Menu components to compose the user interface: a. Implement a program demonstrating various possibilities for changes in the color, size and font style (of the displayed TextView content), as a result of pressing different buttons or selecting various menu options. b. Create and implement a general-purpose mathematical calculator. c. Develop some kind of multiple-choice e-learning application, that supports memorizing the correlation of predefined number of word-pairs, in two different languages (e.g. Polish and English)	04

2	• Mobile Apps be developed for different application for Android as well as IoS Platform. Theme of final Android project may be proposed by student. • Each student selects at least two of mobile technology aspects: a. mobile database (SQLite) b. built-in smartphone sensors: accelerometer, gyroscope, magnetometer, gps c. networking, data synchronization or web services d. 3D graphics or animation on mobile device e. Bluetooth communication between mobile devices	04
3	Design Loggers to perform User Localization Through Sensors of Smartphones. Collect data using the designed mobile App and present the results.	03
4	Develop Mobile Apps based upon Crowdsourcing-Data Collection and Data Analysis	02

Course Outcomes: At the end of the course, students will be able to:	
1	Grasp the concepts and features of mobile computing technologies and applications
2	Identify the important issues of developing mobile computing systems and applications
3	Organize the functionalities and components of mobile computing systems into different layers and apply various techniques for realizing the functionalities

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Theodore S. Rappaport, Wireless Communications: Principles and Practice, Second Edition, Prentice Hall,	2002
2	Ivan Stojmenovic, Handbook of Wireless Networks and Mobile Computing, John Wiley & Sons	2002
3	Mohd. Ilyas & Imad Mahgoub, Mobile Computing Handbook, CRC Press/Aurbach Publications, ISBN 0-8493-1971-4, Boca Raton USA.	2005
4	Reza B'Far, Mobile Computing Principles: Designing and Developing Mobile Applications with UML and XML, Cambridge University, 2004	2004
5	Reto Meie, Professional Android Application Development (Wrox Programmer to Programmer), Wrox, 2008	2008
6	Axel Küpper, Location-Based Services: Fundamentals and Operation, Wiley, 2005.	2005

Course Name	**:**	**DIGITAL IMAGE PROCESSING**
Course Code	**:**	**CS2711**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – IV (DEC-IV) CIS**

Course Objectives:
The students should be able to learn the basic theory and algorithms that are widely used in digital image processing. They should learn current technologies and issues that are specific to image processing systems. They should develop hands-on experience to process images.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION AND FUNDAMENTAL TO DIGITAL IMAGE PROCESSING** Origin of Digital Image Processing, Fundamental steps in Digital Image Processing, Components of Digital Image Processing System, Image sensing and acquisition, Image sampling, quantization and representation, Basic relationship between pixels, Color Fundamentals, Color models, Basis of full color image processing, Color Transformations.	**9**
2	**IMAGE ENHANCEMENT IN THE SPATIAL DOMAIN & FREQUENCY DOMAIN** Basic grey level transformation, Histogram processing, Basics of Spatial filtering, Smoothing and Sharpening spatial filters, Introduction to Fourier Transform and the Frequency Domain, Discrete Fourier Transform, Smoothing and Sharpening Frequency Domain filters.	**9**
4	**IMAGE RESTORATION & IMAGE COMPRESSION** Image Degradation/Restoration Process, Noise models, restoration in presence of noise, Inverse filtering, Minimum Mean Square Filtering, Geometric menu filter, Geometric transformations, Fundamentals, Image compression models, Error free compression, Lossy compression.	**8**
5	**IMAGE SEGMENTATION, REPRESENTATION, DESCRIPTION AND RECOGNITION** Detection of Discontinuities, Edge linking and boundary detection, Threshold, Region oriented segmentation, Representation-chain codes, polygonal approximation and skeletons, Boundary descriptors, simple descriptors, shape numbers, Regional descriptors, topological descriptors.	**8**
6	**PATTERN RECOGNITION** Pattern and pattern classes, Tree classifiers: Decision trees, random forests, Parametric techniques: Maximum likelihood Estimation, Non-Parametric techniques: Kernel Density estimators, Nearest Neighbor methods	**8**

List of Experiments:		**Number of Turns**
1	Implement the basic commands/ functions of an image processing tool.	1
2	Take an input image and plot its histogram with various ways as imhist, bar, stem, plot and Prove that histogram processing can be used for image enhancement	1

3	Filtering using MATLAB package.	1
4	Filtering for Blurring and Sharpening the image.	1
5	Implement various Nonlinear Spatial Filters.	1
6	Implement various types of filters to remove the noise in an image.	1
7	Implement image compression algorithms.	1
8	Design problems related to image segmentation.	1
9	Design problems related to image recognition, pattern recognition.	1

Course Outcomes: At the end of the course, students will be able to:	
1	Develop simple image processing applications.

Suggested Books:		
Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	Digital Image processing By Rafael C. Gonzalez and Richard E. Woods- Pearson Education.	Latest Edtion
2	Digital Image Processing by A.K. Jain, PHI	Latest Edtion
3	Digital Image processing (An algorithmic approach) By Madhuri A. Joshi - PHI	Latest Edtion

Course Name	**:**	**Cloud Computing**
Course Code	**:**	**CS2712/CS4706 (DEC-IV / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – IV (DEC-IV) CIS**

Course Objectives:
Students should be able to understand the concepts, processes, and best practices needed to successfully secure information within Cloud infrastructures
They should learn the basic Cloud types and delivery models. They should develop an understanding of the risk and compliance responsibilities and challenges for each Cloud type and service delivery model

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO CLOUD COMPUTING** Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing	**3**
2	**CLOUD COMPUTING ARCHITECTURE** Introduction to cloud computing architecture, On Demand computing virtualization at the infrastructure level, CPU virtualization, Discussion on hypervisors storage virtualization, The SPI framework for cloud computing, The cloud services delivery model	**7**
3	**CLOUD DEPLOYMENT MODELS** Key drivers to adopting the cloud, The Impact of cloud computing on users, Governance in the cloud, Barriers to cloud computing adoption in the enterprise	**3**
4	**SECURITY ISSUES IN CLOUD COMPUTING** Security in cloud computing environment, Infrastructure Security: The Network level, The host level, The Application level, Data security and storage, Aspects of data security, Data security mitigation provider	**7**
5	**IDENTITY AND ACCESS MANAGEMENT** Trust Boundaries and IAM, IAM Challenges, Relevant IAM standards and protocols for cloud services, IAM practices in the Cloud, Cloud authorization management	**5**
6	**SECURITY MANAGEMENT IN THE CLOUD** Security management standards, Security management in the cloud, Availability management: SaaS, PaaS, IaaS	**5**
7	**PRIVACY ISSUES** Privacy issues, Data life cycle, Key privacy concerns in the cloud, Protecting privacy, Changes to privacy risk management and compliance in relation to cloud computing, Legal and regulatory implications, U.S. laws and regulations, International laws and regulations	**5**
8	**AUDIT AND COMPLIANCE** Internal policy compliance, Governance, Risk, and Compliance (GRC), Regulatory/External compliance, Cloud security alliance, Auditing the cloud for compliance, Security-as-a-cloud	**5**

9	**ADVANCES** Grid of clouds, Green cloud, Mobile cloud computing, Fog computing	**2**

List of Experiments:		**Number of Turns**
1	Installation & configuration of Oracle Virtual box for Windows XP & Android	**2**
2	Installation & configuration of Hadoop	**2**
3	Using Hadoop for counting word frequency with map reduce	**1**
4	Service deployment research & uses over cloud- Google app & Amazon web services	**2**
5	Mobile App Development using Google app & Amazon web services	**4**
6	Performance evaluation of services over cloud- Google App &Amazon Web Services	**1**
7	Design and deploy a private cloud using open source tools	**1**

Course Outcomes: At the end of the course, students will be able to:	
1	To define core concepts of the cloud computing paradigm and distinguish between cloud providers and 3rd party managed service providers
2	Implement a public cloud instance using a public cloud service provider
3	Apply and analyze trust-based security model to different layers in the infrastructure stack

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Cloud Computing Explained: Implementation Handbook for Enterprises, John Rhoton	2013
2	Buyya K, R., Broberg J. and Goscinski M. A., Cloud Computing: Principles and paradigms, MIT Press (2011)	2011
3	Cloud Computing Bible by Barrie Sosinsky Wiley Publication, ISBN-10: 0470903562	2011
4	Introduction to Cloud Computing by Timothy Chou	2010
5	Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance (Theory in Practice), Tim Mather, ISBN-10: 0596802765,O'Reilly Media	2009

Course Name	**:**	**Computer Networks**
Course Code	**:**	**CS6701/CS5701 (OE-III / MSC)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Open Elective – III (OE-III) Minor Specialization Course (MSC)**

Course Objectives:

- Students should be able to have an understanding of the fundamental concepts of computer networking and have a basic knowledge of the various network models and their uses.
- They should be able to understand the organization of computer networks, factors influencing computer network development and the reasons for having variety of different types of networks.
- They should be able to analyze simple protocols and independently study literature concerning computer networks.

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
11.	**COMPUTER NETWORKS AND THE INTERNET** What is the Internet; network edge; network core; Delay, Loss and throughput in Packet-Switched Networks; Protocol Layers and their Service Models.	6
12.	**APPLICATION LAYER** Principles of Network Applications; The Web and HTTP; File Transfer: FTP;Electronic Mail in the Internet; DNS - The Internet's Directory Service	8
13.	**TRANSPORT LAYER** Introduction and Transport-Layer Services; Multiplexing and Demultiplexing; Connectionless Transport: UDP; Connection-Oriented Transport: TCP; TCP Congestion Control.	10
14.	**NETWORK LAYER** Introduction; Virtual circuit and datagram networks; What is inside a router; Internet Protocol (IP): Forwarding and Addressing in the Internet; Routing Algorithms; Routing in the Internet	10
15.	**DATA LINK LAYER** Introduction to the link layer; Error Detection and Correction Techniques; Multiple Access links and Protocols; Switched local area networks.	8

List of experiments:	**No. of Turns**

7.	Understanding and using of commands like ping, ipconfig, hostname, getmac, arp, nslookup, netstat, tracert, route,pathping	2
8.	Socket Programming – Installing and learning Linux operating system, Understanding the syntax, purpose and use of various functions used in sockets 172rogramming – connect(), send(), recv(), bind(), listen(), accept(), sendto(), recvfrom() etc. functions, TCP/IP based echo client server and UDP/IP based echo client server	3
9.	Practicals based on Wireshark – getting started, HTTP, DNS, TCP, IP, ICMP, Ethernet & ARP, DHCP etc.	9

Course Outcomes:	
At the end of the course, students will be able to:	
12.	Independently understand basic computer network technology.
13.	Understand and explain various components of computer networks.
14.	Identify the different types of network topologies and protocols.
15.	Enumerate the layers of the OSI model and TCP/IP. Explain the function(s) of each layer.
16.	Identify the different types of network devices and their functions within a network.
17.	Understand and build the skills of routing mechanisms.
18.	Familiarize with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.

Suggested Books:		
Sr. No.	**Name of books / Author/ Publisher**	**Year of Publication/ Reprint**
21.	James F. Kurose and Keith W. Ross, “Computer Networking: A top down approach”, Pearson Education, 6th edition.	2017
22.	A.S. Tanenbaum, “Computer Networks”, 5th Edition, PHI	2010
23.	G. Keiser, “Local Area Networks”, 2nd Edition, TMH	2002
24.	D. Bertesekas and R. Gallager, “Data Networks”, 2nd Edition, PHI	2010
25.	William Stallings, “Data & Computer Communication”, PHI, 10th Edition	2013
26.	B.A. Forouzan, “Data communications and networking”, TMH, 5th Edition	2012
27.	B.A. Forouzan, “Local Area Networks”, TMH.	2002
28.	B.A. Forouzan, “TCP/IP Protocol Suite”, TMH.	2004

Course Name	**:**	**COMPUTER ARCHITECTURE AND ORGANIZATION**
Course Code	**:**	**CS6702**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Open Elective – IV (OE-IV)**

Course Objective:

- Students should be able to understand basic principles of Computer Systems.
- They should be able to understand various logic design techniques and their applications.
- They should be capable of analyzing the system performance.

Total No. of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1	**BASICS** Introduction to computers with block diagrams, Impact of technology. Designing combinational and sequential logic, computers registers and instructions, timing, and control, instructions cycle, memory reference instruction, I-O interruption.	5
2	**COMPUTER ARITHMETIC** Adder and Subtractor circuits, Booth Multiplication Algorithm, Performance bench marks.	7
3	**CONTROL PATH DESIGN** Sequence counter method, Micro programmed controllers address sequencing, symbolic microinstructions	7
4	**CENTRAL PROCESSING UNIT** Registers General register organization, stack organization, instructions formats, address instructions, addressing modes, data transfer and manipulations, program control, RISC instruction set design, three address instructions and arithmetic pipelines with example of floating point adder, instructions pipelines , advanced pipelining using instruction level parallelism.	10
5	**MEMORY ORIGINATION** Memory device characteristics, Random Access Memory, Serial Access Memory, virtual memory, associative memory, cache memory, memory management hardware, hierarchy of various memories.	7
6	**I/O ORGANIZATION** I/O interface asynchronous data transfer, DMA interrupt, I/O processor.	6

List of Experiments		**Number of Turns**
1	Practicals based on computer arithmetic, control design, CPU design, memory organization and I/O organization	14

Course Outcomes: At the end of the course, students will be able to:	
1	Design the organization of the Control unit, Arithmetic and Logical unit, Memory unit and the I/O unit.
2	Learn different computer architectures and hardware.

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of publication**
1	M. Morris Mano, Computer System & Architecture, Prentice Hall of India	2002
2	John L. Hennessy and David A Patterson, Computer Architecture-A quantitative approach, Morgan Kaufmann/ Elsevier, 4th Edition	2007
3	Hayes .J.P, Computer architecture and organization by McGraw-Hill Companies	1998
4	M.Morris and Charles R. Kinre , Logic and computer design Fundamental, PHI	1995

Course Name	**:**	**Special Topics in Wireless & Mobile Networks**
Course Code	**:**	**CS3701**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Departmental Honours Course – 3 (DHC-3)**

Course Objectives:

- To introduce the basic concepts of wireless transmission
- To get a basic introduction to key concepts and techniques underlying cellular communication and medium access control in wireless networks
- To learn the architecture and issues related to IEEE 802.11 wireless LAN
- To understand the functioning of different types of wireless networks including mobile adhoc and sensor networks

Total number of Lectures: 42

Lecture wise breakup		**No. of Lectures**
1.	**Introduction to wireless networking** Advantages and disadvantages of wireless networking, Evolution of Mobile Communication generations, Multiple Access Technologies- CDMA, FDMA, TDMA, Frequency reuse, Radio Propagation and Modeling, Challenges in mobile computing: Resource poorness, Bandwidth, energy, etc.	6
2.	**Cellular Concepts** Cellular architecture, Frequency reuse, Channel assignment strategies, Handoff strategies, Interference and system capacity, Improving coverage and capacity in cellular systems, Spread spectrum Technologies, Protocols for digital cellular systems such as GSM, EDGE, GPRS, UTMS	8
3.	**IEEE 802.11 WLAN** Wireless LANs Physical & MAC layer, IEEE 802.11 standards, Architecture & protocols, Infrastructure vs. Adhoc Modes, Hidden Node Problems, Fading Effects in Indoor and outdoor WLANs, WLAN Deployment issues**,** TCP over wireless networks, Approaches to improve transport layer performance.	9
4.	**Ad hoc Networks** Introduction, Routing protocols - Destination sequenced distance vector algorithm, Cluster based gateway switch routing, , Ad hoc on-demand routing, Location aided routing, Zonal routing algorithm.	6
5.	**Wireless Sensor Networks** Introduction, Application, Physical, MAC layer and Network Layer,Power Management, Tiny OS	5
6.	**Wireless PANs** Bluetooth AND Zigbee, Introduction to Wireless Sensors, Introduction to Vehicular Adhoc Networks	4

7.	**Security in wireless Networks** Vulnerabilities, Security techniques, Wi-Fi Security, IEEE 802.11x and IEEE 802.11i standards, DoS in wireless communication	4

List of experiments:		**No. of Turns**
1.	Understanding and configuring several networking devices such as routers, computers, cables, wireless router, access points etc.	2
2.	Measuring signal power strength, throughput, and delays of a wireless network	2
3.	Experiments for ad hoc routing in a multi-hop wireless network and experiments for a network of wireless sensor nodes and motes.	4
4.	Discovering devices, building ad hoc net, increasing the coverage of the wireless net, using static or mobile nodes, etc.	2
5.	Simulation of various mobile and wireless network protocols, evaluate and analyse network performance	4

Course Outcomes:	
At the end of the course, students will be able to:	
1.	Grasp the concepts and characteristics of wireless signals and transmission channels
2.	Understand various types of multiple radio access techniques, cellular and underlying propagation and performance analysis concepts
3.	Identify the various design issues of WLAN, its architecture and related issues
4.	Understand the working principles and design issues of various wireless networks

Suggested Books:		
Sr. No.	**Name of books / Author/ Publisher**	**Year of Publication/ Reprint**
1.	Schiller J., Mobile Communications, Addison Wesley	2000
2.	Stallings W., Wireless Communications and Networks, Pearson Education	2005
3.	Stojmenic Ivan, Handbook of Wireless Networks and Mobile Computing, John Wiley and Sons Inc	2002
4.	Yi Bing Lin and Imrich Chlamtac, Wireless and Mobile Network Architectures, John Wiley and Sons Inc	2000
5.	Pandya Raj, Mobile and Personal Communications Systems and Services, PHI	2004

Semester VIII

Semester VIII

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	HS2801 / HS2802 / HS2803	Business Environment and Business Laws / Entrepreneurship and Project Management / Financial Management	2 2 2	1 1 1	0 0 0	3	HSM-IV
2.	CS2801 to CS2808	Department Elective Course – V (DEC-V)	3	0	2	4	DEC-V
3.	CS6801/ CS5801	*Open Elective –V/ Minor Specialization Course (MSC)	3	0	2	4	OE-V/MSC
4.	CS6802	*Open Elective –VI	3	0	2	4	OE-VI
5.	CS8801	Discipline				2	Discipline
6.	PC7801	Proficiency-II				2	Proficiency
7.	CS7801	Major Project-II	0	0	8	4	Project
					Total Credits	23	
Department Honours Course – 4 (DHC-4)							
8.	CS3801	Computational Cognitive Science	3	0	2	4	DHC-4
					Total Credits (Including Honours)	27	

*Open Elective course will not be offered to B.Tech. (CSE) students

Department Elective Course - V (DEC-V)

Sr. No.	Course Code DEC-V/Major Spec.	Course Name	L	T	P	Credits	Specialization domain
1.	CS2801	Computational Genomics	3	0	2	4	AI& ML
2.	CS2802/CS4801	Computer Vision	3	0	2	4	AI & ML
3.	CS2803	Bioinformatics	3	0	2	4	AI&ML
4.	CS2804/CS4802	Advanced IOT with SDN (Industry 4.0)	3	0	2	4	NSS
5.	CS2805	Computer Crime Investigation and Forensics	3	0	2	4	NSS
6.	CS2806	Advanced Computer Architecture	3	0	2	4	CIS
7.	CS2807/CS4803	Recommender System	3	0	2	4	CIS
8.	CS2808	Advanced Algorithm Design and Analysis	3	0	2	4	CIS

Open Elective – V (OE-V) / Minor Specialization Course (MSC)

Sr. No.	Course Code OE/MSC	Course Name	L	T	P	Credits	Category
1.	CS6801/ CS5801	Operating Systems*	3	0	2	4	OE-V/MSC

*Open Elective course (Operating Systems) will not be offered to B.Tech. (CSE) students

Open Elective – VI (OE-VI)

Sr. No.	Course Code	Course Name	L	T	P	Credits	Category
1.	CS6802	Software Engineering*	3	0	2	4	OE-VI

*Open Elective course (Software Engineering) will not be offered to B.Tech. (CSE) students

Course Name	**:**	**Business Environment And Business Laws**
Course Code	**:**	**HS2801**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
The main aim of this course is to make students understand different types of environment influencing business decisions and to acquaint them with analytical tools that economists use to understand the role of International trade in the world economy.

Total No. of Lectures – 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Business** Scope and Characteristics of Business, Classification of Business Activities, Forms of Ownership of Business: Sole Proprietorship, Partnership, Limited Liability Partnership and Company.	**(5)**
2	**Business Environment** Internal Environment: Concept and Elements (Value System, Vision Mission Objectives, Management Structure, Human Resources, Company Image etc.), SWOT Analysis: Concept and Case Study. External Environment: Micro Environment (Suppliers, Customers, Competitors, Market Intermediaries etc.) and Macro Environment – PESTEL Analysis (Political, Economic, Social, Technological, Ecological and Legal), Case Study on Impact of Environment on Business.	**(5)**
3.	**International Business, Issues and Concepts** Nature, scope and importance, Stages of internationalization of Business-Methods of entry into foreign markets: Licensing, Franchising, Joint Ventures, Strategic Alliances, Subsidiaries and Acquisitions (Case studies relating to subsidiaries and acquisitions), Framework for analyzing international business environment: Domestic, Foreign and Global Environment, Recent Developments in International Business.	**(5)**
4.	**Globalization** Concept, Pros and Cons of Globalization, Impact of Global Environment on Business, Concept of Comparative Advantage, Reforms to Reap Benefit of Globalization, Free Trade v/s Protectionism.	**(3)**
5.	**Corporate Social Responsibility** Concept, Social Responsibility Towards Different Stakeholders, Rationale for CSR CSR – Case Studies on CSR initiatives by companies.	**(2)**
6.	**Corporate Governance** Concept, Elements, Essentials and Structure of Good Governance.	**(2)**
7.	**Partnership Law** Nature of Partnership, Provisions of Partnership Act, Issues Related to Partnership Firm,	**(2)**

	Hypothetical Formation of a Partnership Firm.	
8.	**Company Law and Essentials of a Contract** Nature of Company, Provisions of Company Act, Issues Related to Incorporation of Company,Hypothetical Formation of a Company. Concept and essentials of a contract.	**(4)**

Total No. of Tutorials-14

Hour wise Breakup		**No. of Tutorials**
	Tutorials based on Lectures	14

Course Outcomes:	
1	The students will be able to analyze the impact of environment-national and international on business and formulate appropriate business strategies to compete in the competitive international world.
2	The students will learn how companies follow corporate governance and social responsibility practices along with fulfilling economic objectives.

S.No	**Suggested Books**	**Year**
	Text Books	
1	K. Aswathapa, "Essentials of Business Environment", Himalya Publishing House.	2021
2	Francis Cherunilam, "Business Environment: Text and Cases", Pubs: Himalaya Publications.	2019
	Reference Books	
1	Pathak A., "Legal Aspects of Business", Pubs: McGraw Hill Education.	2021
2	Charles W.L.Hill, "International Business: Competing in the Global Market", McGraw Hill, New York.	2019

S.No.	E-Material
1	International Business Environment, University of London, Coursera
2	Business Organization and Management, Indira Gandhi National Open University, Swayam
3	International Business Environment and Global Strategy, IIM, EdX

Evaluation Scheme		
S.No.	***Category***	***Marks***
1	Mid Term	20
2	Assignments/Quizzes/Case Study	20
3	Project Report and Presentation	20
4	End Term	40

Course Name	**:**	**Entrepreneurship and Project Management**
Course Code	**:**	**HS2802**
Credits	**:**	**3**
L T P	**:**	**2-1-0**

Course Objective:
The main aim of this course is to make prospective engineers familiar with the concept of entrepreneurship and MSMEs and to provide knowledge about different aspects to be considered while formulating the business plan for a new entrepreneurial venture.This course also intends to create awareness among students about financial and marketing functions that is required for a new venture.

Total No. of Lectures – 28

Lecture wise breakup		**No. of Lectures**
1	**Introduction to Entrepreneurship** Concept of Entrepreneurship, Characteristics and Functions of Entrepreneur, Forms of Ownership of Business, Factors Affecting Entrepreneurship, Case Studies of Entrepreneurs.	**(6)**
2	**Women Entrepreneurship** Nature of Women Entrepreneurship, Problems of Women Entrepreneurs, Institutional Initiatives for Promotion of Women Entrepreneurs.	**(2)**
3	**Micro, Small and Medium Enterprises (MSMEs)** Concept of MSMEs, Schemes of MSMEs, Functions of Entrepreneurial Development Programmes (EDPs).	**(2)**
4	**Project Identificationand Basic Terminology of Project Management, Knowledge Areas and Process Groups** Introduction to terms Project Management, Program Management and Portfolio Management.Knowledge areas consisting of Project scope, time, cost, HR, communication, quality, risk, procurement and integration management, Process groups consisting of Initiating, Planning, Execution and Closure,Project Life Cycle.	**(4)**
5	**ProjectDetails** Elements of Project Formulation: Product, Technical (Location, Scale, Technology, Production Process, Layout, Manpower, Resources), Market, Finance and Economic Aspects Feasibility Analysis: Financial Viability and Profitability, and Socio-Economic Desirability.	**(5)**
6	**Creation of Overall Business Plan and Project Report** Formulation of Business Plan and Project Report, Hypothetical Example of a Real Life Project	**(2)**
7	**Finance and Marketing Function** Concept of Finance, Finance Related Terminologies, Sources of Finance, Cost Estimations	**(5)**

	Marketing Mix: Product, Place, Price, Promotion, People, Process and Physical Evidence Marketing Segmentation Targeting and Positioning	
8	**Discussions on Additional Reading**(any one of the following in the semester) - The New Age Entrepreneurs - The $100 Startup: Fire your Boss, Do what you Love and Work Better to Live More - A Guide to Entrepreneurship - Dhandha: How Gujaratis Do Business - Rokda: How Baniyas Do Business - Take Me Home - Business Families of Ludhiana	**(2)**

Total No. of Tutorials-14

Hour wise Breakup		**No. of Tutorials**
	Tutorials based on Lectures	14

Course Outcomes:	
1	The students will be able to apply engineering knowledge effectively in the field of entrepreneurship development.
2	The students can make effective use of entrepreneurial knowledge to start and manage their venture.
3	The students will learn to check the feasibility of a new project to maintain its long run sustainability.

Suggested Books:		
S.No.	***Name of Book/ Authors/ Publisher***	***Year of Publication/ Reprint***
	Text Books	
1	"Dynamics of Entrepreneurial Development & Management", Desai V., Pubs: Himalaya Publishing House.	2018
2	"Projects: Planning, Analysis, Selection, Financing, Implementation and Review", Chandra P., Pubs: McGraw-Hill Education (India).	2018
	Reference Books	
1	"Entrepreneurship", Roy R., Pubs: Oxford University Press	2019
2	"Entrepreneurship Development in India", Gupta C.B. and Srinivasan N.P., Pubs: Sultan Chand and Sons.	2018

Suggested E-Material:		
S.No.	***Title/Name of Authors/(Type of material)***	***Retrieval Source***

1	"Business Analysis for Engineers", Vaidhyasubramaniam S. (video)	www.nptel.ac.in/courses/110106050/
2	"Infrastructure Finance", Rajan A. Thillai. (video)	www.nptel.ac.in/courses/110106043/
3	"Strategic Marketing – Contemporary Issues", ChatterjeeJayanta. (video)	www.nptel.ac.in/courses/110104055/

Evaluation Scheme		
S.No.	***Category***	***Marks***
1	Mid Term	20
2	Assignments/Quizzes/Case Study	20
3	Project Report and Presentation	20
4	End Term	40

Course Name	**:**	**FINANCIAL MANAGEMENT**
Course Code	**:**	**HS2803**
Credits	**:**	**3**
LTP	**:**	**2-1-0**

Course Objectives:
The main aim of this course is to make students learn different financial decisions i.e. investing, financing and dividend, required to be taken by a company and provideknowledge about the functioning of the financial system (financial markets, financial institutions, financial services and financial instruments) of the country.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**Introduction To Financial Management** Concept of Finance, Terminology Related to Finance, Financial Decisions, Factors Affecting Financial Decisions, Risk-Return Trade-Off- Risk associated with investment.	4
2	**Long Term Investment Decisions** Capital Budgeting: Concept, Importance, Factors, Techniques/Methods with Numerical Applications (Pay Back Period, Accounting Rate of Return, Net Present Value, Internal Rate of Return and Profitability Index), Case Study.	3
3	**Short Term Investment Decisions** Working Capital: Rationale, Type and Factors Affecting the Composition of Working Capital, Case Study.	2
4	**Financing Decisions** Capital Structure: Essentials and Approaches of Capital Structure (Relevance and irrelevance of capital structure), Sources of Finance (long-term and short-term), Financial Leverage: Favorable and unfavorable, Numerical Application, Understanding of EBIT-EPS Analysis, Case Study.	3
5	**Dividend Decisions** Types of Dividend, Dividend Policy: Nature and Factors Affecting Dividend Policy,CaseStudy.	2
6	**Financial Planning** Objectives, Benefits, Steps and tools in Financial Planning, Factors Affecting Financial Plan, Estimation of Financial Requirements of a firm, Budget Analysis –meaning and types of budget, advantages of budgeting.	2
7	**Financial System** Concept and Role of Financial System in Indian Economy.	2
8	**Financial Markets And Instruments** Relevance of Money Market and Capital Market, Money Market Instruments: Call Money, Treasury Bills, Commercial Papers, Certificate of Deposits; Capital Market Instruments: Equity Shares, Preference Shares and Debentures, Trading Mechanism,Hypothetical Trading in Financial Markets.	4
9	**Financial Services** Nature and Functions of Financial Services:Merchant Banking, Mutual Funds, Factoring, Forfaiting, Credit Rating. Case Study on Financial Services	4

10	**Financial Institutions** Nature and Functions of Financial Institutions: Reserve Bank of India (RBI), Securities and Exchange Board of India (SEBI), Discount and FinanceHouse of India (DFHI).	2

Total No. of Tutorials-14

Hour wise Breakup		**No. of Tutorials**
	Tutorials based on Lectures	14

Course Outcomes:	
1	The students will learn to make best combination of financial decisions by considering risk and return trade-off.
2	The students will identify how business can gain maximum through the financial system.
3	The students will understand how to manage funds effectively so as to maximize returns.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
	Text Books	
1	Pandey I.M., "Financial Management", Pubs: Pearson.	2021
2	F Mishkin and S Eakins, Financial Markets and Institutions: Pearson.	2020
	Reference Books	
1	Pathak B.V., "The Indian Financial System: Markets, Institutions and Services", Publisher: Pearson India.	2019
2	Khan, M.Y & Jain, P.K.: Financial Management; Tata McGraw Hill, New Delhi	2019

Evaluation Scheme		
S.No.	***Category***	***Marks***
1	Assignments/Quizzes/Case Study	20
2	Project Report and Presentation	20
3	Mid Semester Exam	20
4	End Term	40

Course Name	**:**	**Computational Genomics**
Course Code	**:**	**CS2801**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course		**Department Elective Course – V (DEC-V) AI&ML**

Course Objectives:
Students should understand the use of computational and statistical analysis to decipher biology from genome sequences and related data including both DNA and RNA sequence.

Total No. Lectures: 42

Lecture wise breakup		**Number of Lectures**
1	**COMPUTATIONAL GENOMICS** Genomics, concept, scope and applications, its importance, computational genomics, the role of computer scientists, notable successes, the role of DNA sequencing	**3**
2	**DNA MODIFYING ENZYMES AND CLONING TECHNIQUES** Restriction Endonucleases, DNA Ligation Enzymes and, DNA, Gene cloning methods and strategies: Cloning of PCR products, TA cloning, DNA Modifying Enzymes: Nucleases, Kinases, phosphatases, Reverse transcriptase	**6**
3	**CLONING AND EXPRESSION VECTORS** Plasmid Vectors, Vectors based on Lambda Bacteriophage, Cosmids, M13 Vectors, Vectors for Cloning Large DNA Molecules, Expression Vectors	**6**
4	**CONSTRUCTION & SCREENING OF GENOMIC LIBRARIES** Genomic library, cDNA library, Growing& Storing Libraries, cDNA Cloning (5'&3'RACE)	**4**
5	**GENE TRANSFER METHODS** Gene Transfer methods plants and animal cells, Transgenic plants and animals and their applications	**4**
6	**STRUCTURAL GENOMICS** Genome Analysis, Genomics: Organization and structure of Genomes, genome complexity Sequencing genes and short stretches of DNA: Basic DNA sequencing, Next generation sequencing technologies	**7**
7	**MAPPING AND SEQUENCING GENOMES** Introduction, Molecular Markers Genetic and Physical Mapping of Genomes, *I,* Sequence analysis of genomic DNA for identification of genes and other features data and molecular phylogenetics	**6**
8	**FUNCTIONAL GENOMICS**	**4**

	RNA expression analysis Comparative genomics	
9	**APPLICATION DOMAINS OF GENOME TECHNOLOGIES** Genomics and Medicine, Genomics and Agriculture	**2**

List of Experiments:		**Number of Turns**
1	Hands-on with genomic libraries	**2**
2	Hands-on with gene cloning methods	**3**
3	Hands-on with structural genomics approaches	**3**
4	Hands-on with mapping and sequencing of genes	**3**
5	Hands-on with RNA expression analysis	**3**

Course Outcomes: At the end of the course, students will be able to:	
1	Describe and understand terminology, underlying principles and strategies, and the technical methodology involved in genomics
2	Develop understanding of DNA and genome sequencing technologies.
3	Apply and analyze dynamic alignment and sequence classification techniques in genomics

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Computational Biology: Genomes, Networks, Evolution. MIT press	2006
2	Introduction to computational genomics, Nello Cristianini	2006
3	Functional Genomics: Methods and Protocols, Claudia Klinger, Michael Kaufmann	2011
4	Structural Genomics: General Applications, Yu Wai Chen	2013

Course Name	**:**	**Computer Vision**
Course Code	**:**	**CS2802/CS4801 (DEC-V / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – V (DEC-V) AI&ML**

Course Objectives:
The main objectives of this course are:.
1. To understand techniques, mathematical concepts and algorithms used in computer vision to facilitate further study in this area.
2. To implement different concepts and techniques covered.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**Digital Image Formation and low-level processing** Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing.	**7**
2	**Depth estimation and Multi-camera views** Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.	**7**
4	**Feature Extraction** Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	**7**
5	**Image Segmentation** Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection.	**7**
6	**Pattern Analysis** Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.	**7**
7	**Motion Analysis** Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.	**7**

List of Experiments:	**Number of Turns**

1	Implement the basic commands/ functions of an image processing tool.	1
2	Take an input image and plot its histogram with various ways as imhist, bar, stem, plot and Prove that histogram processing can be used for image enhancement	1
3	Implement various edge detection algorithm.	1
4	Implement segmentation algorithm.	1
5	Implement different clustering methods.	1
6	Implement motion analysis using optical flow and motion history image.	1
7	Project Implementation.	1
8	Project Implementation.	1
9	Project Implementation..	1

Course Outcomes: At the end of the course, students will be able to:	
1	Develop simple image processing applications.

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Digital Image processing By Rafael C. Gonzalez and Richard E. Woods-Pearson Education.	Latest Edtion
2	Digital Image Processing by A.K. Jain, PHI	Latest Edtion
3	Practical Computer Vision Applications Using Deep Learning with CNNs: With Detailed Examples in Python Using TensorFlow and Kivy, Apress	Latest Edtion

Course Name	**:**	**Bioinformatics**
Course Code	**:**	**CS2803**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – V (DEC-V) AI&ML**

Course Objectives:
Students should understand the basic concepts behind the sequence, structural alignment, database searching, protein structure prediction and applications of bioinformatics.

Total No. Lectures: 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** History, scope and important contributions, aims and tasks of Bioinformatics, applications of Bioinformatics, challenges and opportunities, introduction to NCBI data model, various file formats for biological sequences	**5**
2	**BIOLOGICAL DATABASES** Importance of databases, biological databases, primary sequence databases, composite sequence databases, secondary databases, nucleic and sequence databases, protein sequence databases, structure databases, bibliographic databases, specialized genomic resources, analysis packages	**6**
3	**DATABASE SEARCH METHODS** Methods for searching sequence databases like FASTA and BLAST algorithms, Statistical analysis and evaluation of BLAST results.	**6**
4	**SEQUENCE COMPARISON METHODS** Methods for comparison of two sequences, Needleman Wush and Smith Waterman algorithms. Analysis of computational complexities, merits and demerits of these algorithms, theory of scoring matrices and their use for sequence comparison	**7**
5	**SEQUENCE ALIGNMENT METHODS** Sequence analysis of biological data, significance of sequence alignment, pair wise sequence alignment methods, use of scoring matrices and gap penalties in sequence alignments, multiple sequence alignment methods, tools and applications of multiple sequence alignment	**7**
6	**SCORING MATRICES** Similarity searches-PAM and BlOSUM matrix, Dayhoff mutation matrix, construction of PAM and BLOSUM matrix. Differences between PAM & BLOSUM	**5**
7	**GENE PREDICTION** Gene prediction strategies, protein prediction strategies, molecular visualization tools, phylogenetic analysis: concept of trees, phylogenetic trees and multiple alignments.	**6**

List of Experiments:		Number of Turns
1	Hands-on with Nucleic acid databases (NCBI, DDBJ, EMBL), Protein databases (Primary, Composite and Secondary)	**2**
2	Hands-on with Specialized Genome databases (SGD, TIGR, ACeDB), Structure databases (CATH, SCOP, PDBsum)	**2**
3	Hands-on with methods for searching sequence databases	**3**
4	Hands-on with sequence comparison and sequence alignment methods	**3**
5	Hands-on with predictive methods	**2**

Course Outcomes: At the end of the course, students will be able to:	
1	Use theoretical approaches to model and analyse complex biological systems
2	Apply the knowledge of bioinformatics in the biotechnology research and industry
3	Analyze sequence and bio-molecular data

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication / Reprint
1	Ghosh Z, and Mallick B, Bioinformatics – Principles and Applications, Oxford University Press	2008
2	Xiong J, Essential Bioinformatics, Cambridge University Press	2006
3	Minoru Kanehesa, “Post-genome Informatics”, Oxford University Press UK	2000
4	C.A. Orengo et al., “Bioinformatics- Genes, Proteins and Computers” BIOS Scientific Publishers	2003

Course Name	**:**	**Advanced IoT with SDN (Industry 4.0)**
Course Code	**:**	**CS2804/CS4802 (DEC-V / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – V (DEC-V) NSS**

Lecture wise breakup		**Number of Lectures**
1.	**Advanced IoT** Introduction to IoT: definition and characteristics, IoT physical design, Communication models, Introduction to IoT ecosystem, IoT, Security, Deployment strategies	**3**
2.	**IoT Security** Security challenges, Requirements (data confidentiality, encryption, authentication, secured access control), IoT attacks, Securing IoT environment, Secured protocols and Frameworks	**7**
3.	**Advanced IoT Applications** First responder IoT networks, Sensors and protocols for next generation automobiles, Automotive IoT, Speech to text processing, Air quality monitoring, Localization in IoT, Smart energy monitoring, Cargo monitoring	**6**
4.	**Industrial IoT (IIOT)/Industry 4.0** Model of Industry 4.0: Concepts, deployment, business model and reference architecture, Industrial IoT Layers: sensing, processing and communication, Security aspects and issues in Industry 4.0, IIoT vs Industry 4.0 (is there any difference?)	**8**
5.	**Software-Defined Networking (SDN)** SDN background and motivation: requirements, architecture, characteristics and standards, SDN planes (Data, Control and Application), Network Function Virtualization (NFV), SDN Controllers: Openflow and other derivatives, SDN Security	**8**
6.	**SDN for IoT/IIoT** SDN architecture for IoT, SDN-Scalability for the IoT, SDN Traffic Flow Optimization for the IoT-Security and Connectivity	**5**
7.	**Industrial IoT Application Domains** Healthcare, Petrochemicals, Pharmaceuticals and Power Plants, Ubiquitous connectivity planning for various applications (Blockchain, Data Analytics, Fog Computing), Real world case studies	**5**

Total No. of Lectures – 42

List of Experiments:		Number of Turns
1.	Mininet: A simulation environment for SDN 1. Network Toplology creation and REST API introduction. 2. Influencing flows via cURL commands. 3. Create a network and run a simple performance test. 4. Use “ovs-vsctl” command to directly control open v switch. 5. Dynamically change the network parameters—link delay analysis. 6. Dynamically change the forwarding rules. 7. Mininet Random Topology Generator.	**8**
2.	Collaborative Computing Git and GitHub, YAML, CI-CD pipelines and the Cloud, Jenkins	**6**

Available MOOCs:

1. https://onlinecourses.nptel.ac.in/noc20_cs69/preview
2. https://www.coursera.org/learn/iiot-google-cloud-platform
3. https://www.udemy.com/course/sdn-openflow-nfv-introduction/

Course Name	**:**	**COMPUTER CRIME INVESTIGATION AND FORENSICS**
Course Code	**:**	**CS2805**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of course	**:**	**Department Elective Course – V (DEC-V) NSS**

Course Objectives:
The students should be able to have technical skills and competencies in the field of forensic computing. They should be able to protect the computer system during the forensic examination from any possible alteration, damage, data corruption, or virus introduction. They should understand how information is stored and used on digital devices.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION** Types of computer crime, history, surveys, statistics and global connections ,Aspects of Cyber Warfare and Cyber Terrorism, Dynamic, Human and Technical Aspects of Cyber Warfare and Cyber Terrorism, Identification, Authorization and Access Control	**7**
2	**SOCIAL ENGINEERING** Spam, Phishing and Pharming	**4**
3	**MALWARE** The types, effects and investigations, DoS and Distributed DoS: The causes, mechanisms, case studies and counter-measures.	**7**
4	**NETWORK CRIMES** Hacking methodologies via the Internet and attacks to other networks	**4**
5	**COMPUTER FORENSICS & INVESTIGATION** Preparation of Investigation, Procedures, Understanding Data Recovery, Data Acquisition, Processing Crime & Incident scenes, Current Computer Forensic tools, Computer Forensic Analysis & Validations, recovery Graphic Files, Network Forensics, Email Investigations, Mobile Device Forensics	**10**
6	**LEGAL MEASURES** Computer Misuse, Criminal Damage, Software Piracy, Forgery, Investigative Powers	**4**
7	**CASE STUDIES** Investigations into hacking, cases and PC misuse, Investigations, Incident Handling and Forensic Examination, The Future: The expansion of the Internet, unsuitable material Identity Theft and Fraud	**6**

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Cyber Warfare and Cyber Terrorism , Andrew Colarik and Lech Janczewski, editors Dorothy E. Denning, ISBN13: 9781591409915.	2007
2	Computer Forensics and Investigations, Nelson, Phillips Enfinger, Steuart, CENGAGE Learning	2009
3	Information Warfare and Security, Addison-Wesley, Hedley & Aplin,	1999
4	Blackstone's Statutes on IT and E-Commerce, Oxford University Press, C. Stoll, The Cuckoo's Egg, Pan Book Publishers.	2002

List of Experiments:		Number of Turns
1	Practical problems on Data and Evidence Recovery	2
2	Practical problems on Hacking Methodologies	2
3	Practical problems on Mobile Device Forensics	2
4	Practical problems on Windows Forensics	2
5	Practical using Cyber Forensic Investigation Tools	3
6	Practical problems on Web Browser Forensics and Email Tracing	2

Course Outcomes: At the end of the course, students will be able to:	
1	Demonstrate use of computer forensics tools and appropriate skills and knowledge to perform investigations
2	Analyze digital devices to establish user activity
3	Research the development of new devices and technologies and how current digital forensics methods will apply to them.
4	Gain insight knowledge to understand attack profiles, investigation tools and techniques
5	Gain ability to perform Critical analysis of data to identify evidence
6	Be able to trace malicious internet activity and analyze email trails.

Course Name	ADVANCED COMPUTER ARCHITECTURE
Course Code	CS2806
Credits	4
L T P	3 1 0
Type of Course	Department Elective Course – V (DEC-V) CIS

Course Objectives:
The students should be able to understand computer architecture. They should study architectures exploiting instruction-level parallelism (ILP), and multiprocessors and minicomputers

Total No. of Lectures – 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION TO PARALLEL PROCESSING:** Parallelism in uniprocessor system; parallel computer structure, architectural classification schemes.	**5**
2	**MEMORY MANAGEMENT AND ORGANIZATION:** Memory hierarchy, Virtual memory system, memory allocation and management, cache memory management. Mapping and management techniques, memory replacement policies.	**10**
3	**PIPELINING AND VECTOR ARCHITECTURE:** Instruction and arithmetic pipelines design, linear and non-linear pipeline processors, superscalar and super pipeline design.	**8**
4	**SIMD ARRAY ARCHITECTURE:** SIMD array processors, SIMD interconnection network, Associative array processors.	**7**
5	**MIMD MULTIPROCESSOR AND MULTICOMPUTER:** Multiprocessor architecture (loosely coupled, tightly coupled), interconnection networks, cache coherence and synchronization mechanism multiprocessor operating systems, exploiting concurrency.	**8**
6	**REVIEW OF MODERN PROCESSORS** Pentium Processor: IA 32 and P6 micro architectures, ARM Processor.	**4**

Course Outcomes: At the end of the course, students will be able to:	
1	Understand the advanced concepts of computer architecture.
2	Investigate modern design structures of Pipelined and Multiprocessors systems.
3	Understand the interaction amongst architecture, applications and technology

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Advanced Computer Architectures - A Design space approach, Dezso Sima, Terence Fountain, Peter Kacsuk, Pearson Education.	1997

2	K Hwang, Advanced Computer Architecture, Tata McGraw-Hill Education.	2003
3	David E. Culler, Jaswider Pal, Parallel computer Architecture, Gulf Professional Publishing.	1999
4	John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Third Edition, Morgan Kaufmann.	2002
5	High-performance Computer Architecture, by Harold Stone Addison Wesley, 3rd ed.	1993
6	Parallel Computer Architecture: A Hardware/Software Approach David Culler and J.P. Singh with Anoop Gupta, Morgan Kaufmann.	1998

Course Name	**:**	**Recommender Systems**
Course Code	**:**	**CS2807/CS4803 (DEC-V / Major Specialization)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – V (DEC-V) CIS**

Course Objectives:

- To learn techniques for making recommendations, including non-personalized, content-based, and collaborative filtering
- To automate a variety of choice-making strategies with the goal of providing affordable, personal, and high-quality recommendations

Course Contents: **Total No. Lectures: 42**

Sr. No.	Course contents	No. of Lectures
1.	**Introduction** Overview of Information Retrieval, Retrieval Models, Search and Filtering Techniques: Relevance Feedback, User Profiles, Recommender system functions, Matrix operations, covariance matrices, Understanding ratings, Impact of Bad Ratings, Applications of recommendation systems, Issues with recommender system	08
2.	**Content-based Filtering** High level architecture of content-based systems, Advantages and drawbacks of content based filtering, Item profiles, Discovering features of documents, pre-processing and feature extraction, Obtaining item features from tags, Methods for learning user profiles, Similarity based retrieval, Classification algorithms.	08
3.	**Collaborative Filtering** User-based recommendation, Item-based recommendation, Model based approaches, Matrix factorization, Attacks on collaborative recommender systems.	08
4.	**Hybrid approaches** Opportunities for hybridization, Monolithic hybridization design: Feature combination, Feature augmentation, Parallelized hybridization design: Weighted, Switching, Mixed, Pipelined hybridization design: Cascade Meta-level, Limitations of hybridization strategies	08
5.	**Evaluating Recommender System** Introduction, General properties of evaluation research, Evaluation designs: Accuracy, Coverage, confidence, novelty, diversity, scalability, serendipity, Evaluation on historical datasets, Offline evaluations.	06
6.	Trust-Based Recommendation, Recommending for Groups, Context-Aware Recommendation, Cross-domain Recommendations	04

Lab Work: To follow project based learning approach for the course.

Sr. No.	Lab contents	No. of Hours
1.	Program to explore n**on-personalized data and features**	2
2.	Program for rating conversion from normal data	2
3.	**To compute** Mean Rating, Rating Count , correlation and **generate recommendations**	2
4.	To compute Pearson correlation and cosine similarity for given dataset	2

5.	Write program to that make predictions for the test item-user pair and use user-based or item-based Collaborative Filtering	4
6.	To evaluate recommendations on the basis of accuracy and other metrics	2

Course Outcomes:

At the end of the course, students will be able to:	
1.	Design recommendation system for a particular application domain
2.	Evaluate recommender systems on the basis of metrics such as accuracy, rank accuracy, diversity, product coverage, and serendipity

Bibliography:

Sr. No.	Book Detail	Year of Publication
1.	Recommender Systems: An Introduction, Cambridge University Press 1st ed. Jannach D., Zanker M. and FelFering A.	2011
2.	Recommender Systems: The Textbook, Springer (2016), 1st ed. Charu C. Aggarwal	2016
3.	Recommender Systems Handbook, Springer(2011), 1st ed. Ricci F., Rokach L., Shapira D., Kantor B.P	2015
4.	Recommender Systems For Learning, Springer (2013), 1st ed. Manouselis N., Drachsler H., Verbert K., Duval E.	2013

Course Name	**:**	**ADVANCED ALGORITHM DESIGN AND ANALYSIS**
Course Code	**:**	**CS2808**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Department Elective Course – V (DEC-V) CIS**

Course Objectives:
• Students should develop mathematical skills for algorithm design, analysis and evaluation.
• Students should be able to design and implement efficient algorithmic solutions to various computational problems

Total No of Lectures: 42

Lecture wise breakup		Number of Lectures
1	**INTRODUCTION** Algorithm concepts, asymptotic efficiency of algorithms, asymptotic notations and their properties. Recurrence equations and method of solving recurrences, substitution method, recursion tree method and master method	**5**
2	**PROBABILISTIC ANALYSIS AND RANDOMIZED ALGORITHMS** Probabilistic analysis concepts, hiring problem and its probabilistic analysis.	**4**
3	**STRING MATCHING , SELECTION PROBLEM** Rabin Karp algorithm, String matching with finite automaton, Knuth-Morris-Pratt algorithm. Medians and order statistics.	**5**
4	**DYNAMIC PROGRAMMING** Elements of Dynamic Programming, Longest Common Subsequence problem, Optimal Binary Search trees	**6**
5	**ADVANCED DATA STRUCTURES** B trees, B+ trees, data structures for disjoint sets.	**6**
6	**GRAPH ALGORITHMS** Breadth First and Depth First Search, minimum spanning trees, shortest path algorithms: single source and all pair, max flow problem and its solutions.	**6**
7	**LINEAR PROGRAMMING** Standard and Slack forms, Formulating problems as linear programs, simplex algorithm, representation of polynomials, DFT and FFT.	**4**
8	**NP-COMPLETENESS CONCEPTS** Polynomial time verification, NP-completeness and reducibility, showing problems to be NP-complete like Clique problem, vertex cover problem etc. Approximation algorithms of these problems.	**6**

List of Experiments		Number of Turns
1	Implement string-matching algorithm.	**3**
2	Implement dynamic programming to find longest common subsequence.	**2**
3	Implement B Trees and B+ Trees.	**3**
4	Implement graph algorithms.	**3**
5	Implement Max flow problems	**3**

Course Outcome: At the end of the course the students will be able to	
1	Understand various algorithm design techniques
2	Apply various techniques for computational problems
3	Understand advanced algorithmic concepts and its application in complex problems

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Cormen, Leiserson, Rivest, Stein, "Introduction to Algorithms", Prentice Hall of India.	2009
2	Brassard, Bratley, "Fundamentals of algorithms", Prentice Hall of India.	2001
3	Knuth, "The Art of Computer Programming", Vol I-III, Pearson Education.	2011

Course Name	**:**	**Operating Systems**
Course Code	**:**	**CS6801/CS5801 (OE-V / MSC)**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Open Elective – V (OE-V) Minor Specialization Course (MSC)**

Course Objectives:
Students should be able to describe the purpose, structure and functions of operating system. They should be able to understand the file system, processes synchronization, process scheduling, system calls and memory management techniques used in an operating system.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**CONCEPTS OF OPERATING SYSTEMS** Computer system overview, concept of an operating system, multiprogramming, multiprocessing, multi user, time sharing, Multitasking, personal system, parallel system, real time system, general system architecture, System components, operating system services, system calls, system programs, system structure, Approaches to OS design and implementation	**8**
2	**PROCESSES MANAGEMENT** Concept of process, process states, process state transitions, process control block, operations on processes, Process scheduling , scheduling criteria	**3**
3	**PROCESS SYNCHRONIZATION** Concurrent programming and Deadlocks Critical regions, Conditional critical regions, Monitors, Inter process communication, Messages, Pipes, Semaphores, Modularization, Synchronization, Concurrent languages. Deadlocks: Characterization, Prevention, Avoidance, Detection and Recovery, Combined approach to Deadlock Handling, precedence graphs.	**5**
4	**MEMORY MANAGEMENT** Logical and physical address space, storage allocation and management techniques, swapping concepts of multi programming, paging, segmentation, virtual Memory, demand paging, page replacement algorithm, thrashing	**8**
5	**INPUT/OUTPUT AND DATA MANAGEMENT** File organization, record blocking, access method, directory structure, protection file system structure, allocation methods, free space management, directory implementation, disk structure, disk scheduling, disk management, buffering, swap space management, RAID levels	**8**
6	**NETWORKS OPERATING SYSTEM AND DESIGN PRINCIPLES** Network operating system, distributed operating system, external security, operational security, password protection, access control, security kernels, hardware security, layered approach, design principle.	**4**

7	**OS SECURITY THREATS** Types of Threats in Operating System, Understanding the Threats: Malware, Viruses, Worms, Rootkits, Defense -- An Overview, Logging, Auditing, and Recovery	**3**
8	**CASE STUDIES** Linux/Unix OS design and architecture, Unix shell, Unix operating system services, user perspective, representation of files in Unix system processes and their structure, input-output system, memory management in Unix	**3**

List of Experiments:		**Number of Turns**
1	To perform shell programming	4
2	Implementation of memory management techniques like paging or segmentation	2
3	Implementation of Process scheduling techniques	2
4	Use the system calls of UNIX/Linux operating system: mkdir, rmdir, link, unlink, mount, chown, chmod, getuid, setuid, fork, wait, exec, exit, kill, getpid, brk, nice, sleep, trace, open, close, read, write, lseek, stat, sync	3
5	Use the following system calls of UNIX operating system: signals, pipe, socket, accept, snd, recv, connect	1

Course Outcomes:	
1	Understanding of design issues associated with operating systems
2	Write and/or modify concurrent programs.
3	Master various process management concepts including scheduling, synchronization, and deadlocks.
4	Apply security as well as recovery feature in the design of algorithms.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/ Reprint**
1	Operating system, Galvin & Silberschatz, 9th Edition, John Willey	Latest edition
2	Operating Systems-A Concept Based Approach By Dhamdhare, TMH	Latest edition
3	Operating systems Internals and design principles By William Stallings, Pearson Education	Latest edition
4	Operating Systems –A Design Oriented approach By Crowley, TMH	Latest edition
5	Operating systems Design and Implementation By Andrew S. Tanenbaum, Pearson Education	Latest edition

Course Name	**:**	**SOFTWARE ENGINEERING**
Course Code	**:**	**CS6802**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Open Elective – VI (OE-VI)**

Course Objectives:
Students should understand fundamentals of software engineering. They should learn strengths and weaknesses of various software engineering process models used in industrial applications. They should be able to construct software that is reasonably easy to understand, design, develop, test and modify.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO SOFTWARE ENGINEERING** Software, Software Engineering, Myths, Software Process, Work Products, Importance of Software Engineering.	4
2	**SOFTWARE PROCESS MODELS** Standard for Software Process, Waterfall Model, Prototyping Model, Iterative Enhancement Model, Spiral Model, RAD model, 4th Generation models, Formal Methods, Agile Development, Team Software Process, DevOps, Choosing the best Software Process.	6
3	**REQUIREMENT ENGINEERING** Software Requirements, Types of Requirements, Requirement Engineering Cycle, Requirements Specification document, Characteristics of Requirements, Requirement verification and validation.	4
4	**SOFTWARE PROJECT MANAGEMENT** Role of Management in Software Development, Project Estimation Techniques, Staffing, Scheduling, Earned Value Analysis, Software Risks, Software Configuration Management, Software Process and Project metrics.	6
5	**SOFTWARE DESIGN** Process, Data and Behavioral Modeling, Design Concepts, Modularity, Architectural design, Coupling and Cohesion, Top-down and bottom-up design, Object-oriented Analysis, Function-oriented and Object-Oriented Design approach, Software Design Document.	6
6	**CODING AND TESTING** Coding styles and documentation, Testing principles, Testing strategies, Black-box and White-box Testing Techniques, Levels of testing -unit, integration, system, regression, Test Plan, Test Cases Specification, Software debugging, Software Maintenance.	6
7	**SOFTWARE QUALITY** Software Quality Assurance (SQA), SQA tasks, Software amplification and removal, Formal Technical Reviews, Software Quality Factors, ISO 9126, SEI CMM, CMMI, Software Reliability. Software Availability.	4

8	**ADVANCED TOPICS IN SOFTWARE ENGINEERING** Software Process Improvement, Component Based Software Engineering, Web Engineering, Reverse Engineering, Software Engineering challenges of Big Data, Mobile Applications. **COMPUTER AIDED SOFTWARE ENGINEERING** Computer Aided Software Engineering (CASE) and its Scope, CASE support in Software Life Cycle, Architecture of CASE Environment, Upper CASE and Lower CASE, Exposure to CASE tools.	6
List of Experiments:		**Number of Turns**
1	Team Software Project: Requirements Planning, Prepare Models and Designs, Develop and Test the project.	Throughout Semester
2	UML models exercises.	3
3	Programming exercise to understand and develop test cases for Black-box testing.	1
4	Programming exercise to understand and develop test cases for White-box testing.	1

Course Outcomes: At the end of the course, students will be able to:

1	Understand the concepts of Software Process. Select a suitable Software Process for any project.
2	Design and Test the requirements of the software projects.
3	Design and develop projects using concepts like Applet, AWT class, client and server side scripting.
4	Implement the software development processes activities from requirements to verification and validation.

Suggested Books:

Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	Roger Pressman, Software Engineering: A Practitioner‟s Approach, 7th Edition, McGraw- Hill	2010
2	Ian Sommerville, Software Engineering, 9th Edition, Addision-Wesley.	2016
3	KK Aggarwal and Yogesh Singh, Software Engineering, 3rd Edition, New Age International	2008
4	Pankaj Jalote, A Concise Introduction to Software Engineering, Springer.	2008

Course Name	**:**	**Computational Cognitive Science**
Course Code	**:**	**CS3801**
Credits	**:**	**4**
L T P	**:**	**3 0 2**
Type of Course	**:**	**Departmental Honours Course -4 (DHC-4)**

Course Objectives:
Students should understand an in-depth appreciation of the central challenges in realizing aspects of human cognition (with specific focus on language and memory) on machine, surveys significant breakthroughs in our understanding till date, and identifies avenues for exploration in future.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**OVERVIEW OF COGNITIVE SCIENCE** What is Cognitive Science, Philosophy: Foundations of Cognitive Science, Newell's big question, Constituent disciplines, Interdisciplinary approach, Unity and diversity of cognitive science	**6**
2	**PHILOSOPHY** Philosophy of Mind, Cartesian dualism Nativism vs, empiricism, Mind-body problem, Functionalism, Turing Test, Modularity of mind, Consciousness, Phineas Gage, Physicalism	**6**
3	**NEURAL NETWORK MODELS** Neural Network Models, Processing of sensory information in the brain, Motor and sensory areas, Brain Imaging, fMRI, MEG, PET, EEG, Multisensory integration in cortex, Information fusion from sensation to cognition, Cybernetics, Analog vs. Digital: Code duality	**8**
4	**LINGUISTIC KNOWLEDGE** What is language?, Linguistic knowledge: Syntax, semantics and pragmatics, Generative linguistics, Brain and language, Language disorders, Lateralization, The great past tense debate, Cognitivist and emergent standpoints, A robotic perspective	**7**
5	**ROBOTICS** Affordances, Direct perception, Ecological Psychology, affordance learning in robotics, Development, child and robotic development, Attention and related concepts, Human visual attention, Computational models of attention, Applications of computational models of attentional	**7**

6	**MACHINE LEARNING** Categories and concepts, Concept learning, Constructing memories, Explicit vs. implicit memory, Information processing (three-boxes) model of memory, Sensory memory, Short term memory, Long term memory, Rationality, Bounded rationality, Prospect theory, Heuristics and biases, Reasoning in computers, Key points in social cognition, Context and social judgment, Schemas, Social signals	**8**

List of Experiments:		**Number of Turns**
1	Explore fMRI, MEG, PET, EEG	**3**
2	Investigate and apply memory and decision making methods	**2**
3	Investigate and apply motor control and learning methods	**2**
4	Implement similarity methods on actual users or on computational simulations	**2**
5	Implement categorization methods on actual users or on computational simulations	**3**

Course Outcomes: At the end of the course, students will be able to:	
1	Define and have insight to basic principles of computational cognitive science
2	Understand Brain, sensory motor information and representation of sensory information
3	Evaluate fundamental issues of using a computational approach to explore and model cognition

Suggested Books:		
Sr. No.	**Name of Book/ Authors/ Publisher**	**Year of Publication / Reprint**
1	The Oxford Handbook of Computational and Mathematical Psychology, Jerome R. Busemeyer, Zheng Wang, James T.	2001
2	Cognition, Brain and Consciousness: Introduction to Cognitive Neuroscience, Bernard J. Bears, Nicole M. Gage, Academic Press	2010
3	Quantum Models of Cognition and Decision, Jerome R. Busemeyer, Peter D. Bruza, Cambridge University Pres	2014
4	Formal Approaches in Categorization, Emmanuel M. Pothos, Andy J. Wills, Cambridge University Press	2011