Course Curriculum

B.Tech. IT

"Applicable with effect from 2023 admitted batch and onwards"

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Engineering Physics	AS1001	BSC	4	3-0-2-0
2	Linear Algebra	AS1002	BSC	4	3-1-0-0
3	Problem Solving with Programming	IT1001	ESC/VSEC	5	3-0-4-0
4	Fundamentals of Electrical & Electronics Engineering	EC1001	ESC	4	3-0-2-0
5	Technical Communication Skills	MS1001	HSMC (AEC)	2	1-0-2-0
6	Constitution of India	MS1002	HSMC (VEC)	1	1-0-0-0
	Universal Human Values	MS1003			
	Professional Ethics	MS1004			
	Art of Living	MS1005			
			Total	**20**	**14-1-10-0** / **25**

Semester 2					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Computer Organization and Architecture	IT1002	PCC	4	3-0-2-0
2	Data Structures and Algorithms	IT1003	PCC	4	3-0-2-0
3	Web Development	IT1004	VSEC	2	0-0-4-0
4	Discrete Mathematical Structures	IT1005	PCC	4	3-1-0-0
5	Principles of Data Communication	EC1006	ESC	3	3-0-0-0
6	Principles of Management	MS1006	HSMC (AEC)	2	1-0-2-0
7	Constitution of India	MS1002	HSMC (VEC)	1	1-0-0-0
	Environmental Studies	MS1007			
	Professional Ethics	MS1004			
	Physical Education (Sports)	MS1008			
			Total	**20**	**14-1-10-0** / **25**

Exit: After successful completion of one year (first two semesters), a student may get an exit option as per ordinance. They need to do Skill Based Courses of 6 credits additional, in summer, before exit. Department will provide a list of such courses.

Semester 3					**Total Credit: 24**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Probability and Statistics	AS2001	BSC	3	2-1-0-0
2	Object Oriented Methodologies	IT2001	PCC	4	3-0-2-0
3	Theory of Computation	IT2002	PCC	3	2-1-0-0
4	Operating System	IT2003	PCC	4	3-0-2-0
5	Software Engineering	IT2004	PCC	3	2-0-2-0
6	Multi-Disciplinary Minor-1	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
7	Principles of Economics or Introduction to Finance	MS2001 MS2002	HSMC (AEC)	2	2-0-0-0
8	**Community Services** NCC NSS Yoga Unnat Bharat Abhiyaan Ek Bharat Shreshtha Bharat NGO Prayas Other courses	 MS1010 MS1011 MS1012 MS1013 MS1014 MS1015 MS1016 MS1017-MS1020	HSMC (CEA)	2	0-0-0-4
			Total	**24**	**16-2-10-4** **32**

Semester 4					**Total Credit: 21**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Design and Analysis of Algorithms	IT2005	PCC	4	3-0-2-0
2	Principles of Programming Language	IT2006	PCC	3	3-0-0-0
3	Computer Networks	IT2007	PCC	4	3-0-2-0
4	Computer Graphics and Visualization	IT2008	PCC	3	2-0-2-0
5	Database Management System	IT2009	PCC	4	3-0-2-0
6	Multi-Disciplinary Minor-2	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
			Total	**21**	**17-0-08-0** **25**

Exit: After successful completion of 4 semesters, a student may get an exit option as per ordinance. They need to do ***Skill Based Courses of 6 credits***, additional, in summer, before exit. Department will provide a list of such courses.

Semester 5					**Total Credit: 22**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Cyber Security	IT3001	PCC	4	3-0-2-0
2	Introduction to Machine Learning	IT3002	PCC/VSEC	4	3-0-2-0
3	Image and Video Processing	IT3003	PCC/VSEC	4	3-0-2-0
4	Artificial Intelligence	IT3004	PCC	3	2-0-2-0
5	Project-I (Research Methodology)	IT2501	ELC	2	0-0-4-0
6	Multi-Disciplinary Minor-3	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
7	Design Thinking and Innovation	IT3501	HSMC	2	1-0-2-0
			Total	**22**	**15-0-14-0** **29**

Semester 6					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Analytics	IT3006	PCC	3	2-0-2-0
2	Project-II	IT3559	ELC	4	0-0-8-0
3	Biology for Engineers	AS1010	BSC	2	2-0-0-0
4	Elective-1 (X1 to X100)	IT5501-IT5599	PEC	3	3-0-0-0
5	Elective-2 (Y1 to Y100	IT5501-IT5599	PEC	3	3-0-0-0
6	Multi-Disciplinary Minor-4	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
7	**Indian language(I1-I10)**		HSMC (AEC)	2	1-0-2-0
	Sanskrit	MS1401			
	(I2-I10)	MS1402 – MS1410			
	Foreign language(F1-F10)				
	German	MS1500			
	Japanese	MS1501			
	French	MS1502			
	(F4-F10)	MS1503-MS1510			
	Regional Language(R1-R10)				
	(R1-R10)	MS1600- MS1610			
			Total	**20**	**14-0-12-0** **26**

Exit: After successful completion of 6 semesters, a student any get an exit option after completion of the summer semester internship (3 credits) and additional 3 credit courses in summer.

X1 to X99, Y1 to Y99, I1 to I10, F1 to F10 and R1 to R10 will be decided by concerned department.

Summer Semester					**Total Credit: 3**
Sl. No.	Course Name	Code	Type	Credit	
1	Internship	IT4600	ELC	3	Credit will be added in VII Sem.

Note: Internship will be evaluated in the beginning of seventh semester. Its credit and grades will be reflected in the 7th Semester Grade Sheet.

Semester 7					**Total Credit: 21**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Minor Project	IT4501	ELC	4	0-0-8-0
2	Elective-3 (X1 to X100)	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective-4 (Y1 to Y100	IT5501-IT5599	PEC	3	3-0-0-0
4	Open Elective-1		OEC	3	3-0-0-0
5	Multi-Disciplinary Minor-5	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
6	History of Indian Civilizations	MS1800	HSMC (IKS)	2	2-0-0-0
	Kautilya's Arthashastra	MS1801			
	Vedic Mathematics	MS1802			
	Vedic Corpus	MS1803			
	Wisdom from the Ages	MS1804			
	Panini's Grammar	MS1805			
	(X1 to X9)	MS1806 – MS1815			
7	Internship(Summer Semester)	IT4600	ELC	3	0-0-0-6
			Total	**21**	**14-0-8-6** **6+22**

Semester 8					**Total Credit: 12**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Major Project	IT5601	ELC	6	0-0-12-0 0-0-0-6
2	Elective-5(X1 to X100	IT5501-IT5599	PEC	3	3-0-0-0 0-0-0-3*
3	Open Elective-2		OEC	3	3-0-0-0 0-0-0-3*
			Total	**12**	**6-0-12-0** **18**

*8th Semester courses may be allowed to join via MOOC/NPTEL etc. Major projects may be completed as Internship cum projects. MOOC/NPTEL courses start with level 4.

B.Tech. BIN

"Applicable with effect from 2023 admitted batch and onwards"

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Engineering Physics	AS1001	BSC	4	3-0-2-0
2	Linear Algebra	AS1002	BSC	4	3-1-0-0
3	Problem Solving with Programming	IT1001	ESC/VSEC	5	3-0-4-0
4	Fundamentals of Electrical & Electronics Engineering	EC1001	ESC	4	3-0-2-0
5	Technical Communication Skills	MS1001	HSMC (AEC)	2	1-0-2-0
6	Constitution of India	MS1002	HSMC (VEC)	1	1-0-0-0
	Universal Human Values	MS1003			
	Professional Ethics	MS1004			
	Art of Living	MS1005			
			Total	**20**	**14-1-10-0** / **25**

Semester 2					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Computer Organization and Architecture	IT1002	PCC	4	3-0-2-0
2	Data Structures and Algorithms	IT1003	PCC	4	3-0-2-0
3	Web Development	IT1004	VSEC	2	0-0-4-0
4	Discrete Mathematical Structures	IT1005	PCC	4	3-1-0-0
5	Essentials of Business Informatics	IT 1600	PCC	3	3-0-0-0
6	Principles of Management	MS1006	HSMC (AEC)	2	1-0-2-0
7	Constitution of India	MS1002	HSMC (VEC)	1	1-0-0-0
	Environmental Studies	MS1007			
	Professional Ethics	MS1004			
	Physical Education (Sports)	MS1008			
			Total	**20**	**14-1-10-0** / **25**

Exit: After successful completion of one year (first two semesters), a student may get an exit option as per ordinance. They need to do Skill Based Courses of 6 credits additional, in summer, before exit. Department will provide a list of such courses.

Semester 3					**Total Credit: 24**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Probability and Statistics	AS2001	BSC	3	2-1-0-0
2	Object Oriented Methodologies	IT2001	PCC	4	3-0-2-0
3	Foundation of FinTech	IT2600	PCC	3	2-1-0-0
4	Operating System	IT2003	PCC	4	3-0-2-0
5	Software Engineering	IT2004	PCC	3	2-0-2-0
6	Multi-Disciplinary Minor-1	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
7	Introduction to Finance	MS2002	HSMC (AEC)	2	2-0-0-0
8	**Community Services** NCC NSS Yoga Unnat Bharat Abhiyaan Ek Bharat Shreshtha Bharat NGO Prayas Other courses	 MS1010 MS1011 MS1012 MS1013 MS1014 MS1015 MS1016 MS1017-MS1020	HSMC (CEA)	2	0-0-0-4
			Total	**24**	**16-2-10-4** **32**

Semester 4					**Total Credit: 21**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Design and Analysis of Algorithms	IT2005	PCC	4	3-0-2-0
2	Operation Research	MS2601	PCC	3	3-0-0-0
3	Computer Networks	IT2007	PCC	4	3-0-2-0
4	Digital Marketing	MS2602	PCC	3	2-0-2-0
5	Database Management System	IT2009	PCC	4	3-0-2-0
6	Multi-Disciplinary Minor-2	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
			Total	**21**	**17-0-08-0** **25**

Exit: After successful completion of 4 semesters, a student may get an exit option as per ordinance. They need to do ***Skill Based Courses of 6 credits***, additional, in summer, before exit. Department will provide a list of such courses.

Semester 5					**Total Credit: 22**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Cyber Security	IT3001	PCC	4	3-0-2-0
2	Introduction to Machine Learning	IT3002	PCC/VSEC	4	3-0-2-0
3	Business Process Management	MS3601	PCC/VSEC	4	3-0-2-0
4	Artificial Intelligence	IT3004	PCC	3	2-0-2-0
5	Project-I (Research Methodology)	IT2501	ELC	2	0-0-4-0
6	Multi-Disciplinary Minor-3	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
7	Design Thinking and Innovation	IT3501	HSMC	2	1-0-2-0
			Total	**22**	**15-0-14-0** **29**

Semester 6					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Analytics	IT3006	PCC	3	2-0-2-0
2	Project-II	IT3559	ELC	4	0-0-8-0
3	Biology for Engineers	AS1010	BSC	2	2-0-0-0
4	Process Mining & Analytics	IT3007	PEC	3	3-0-0-0
5	Elective-1 (X1 to X9,Y1 to Y9)	IT5501-IT5599	PEC	3	3-0-0-0
6	Multi-Disciplinary Minor-4	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
7	**Indian language(I1-I10)**		HSMC (AEC)	2	1-0-2-0
	Sanskrit	MS1401			
	(I2-I10)	MS1402 – MS1410			
	Foreign language(F1-F10)				
	German	MS1500			
	Japanese	MS1501			
	French	MS1502			
	(F4-F10)	MS1503-MS1510			
	Regional Language(R1-R10)				
	(R1-R10)	MS1600- MS1610			
			Total	**20**	**14-0-12-0** **26**

Exit: After successful completion of 6 semesters, a student any get an exit option after completion of the summer semester internship (3 credits) and additional 3 credit courses in summer.

X1 to X9, Y1 to Y9, I1 to I10, F1 to F10 and R1 to R10 will be decided by concerned department.

Summer Semester					**Total Credit: 3**
Sl. No.	Course Name	Code	Type	Credit	
1	Internship	IT4600	ELC	3	Credit will be added in VII Sem.

Note: Internship will be evaluated in the beginning of seventh semester. Its credit and grades will be reflected in the 7th Semester Grade Sheet.

Semester 7					**Total Credit: 21**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Minor Project	IT4501	ELC	4	0-0-8-0
2	Big Data Analytics	IT4050	PCC	3	3-0-0-0
3	Elective-3(X1 to X9) (Y1 to Y9)	IT5501-IT5599	PEC	3	3-0-0-0
4	Open Elective-1		OEC	3	3-0-0-0
5	Multi-Disciplinary Minor-5	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3-0-0-0
6	History of Indian Civilizations Kautilya's Arthashastra Vedic Mathematics Vedic Corpus Wisdom from the Ages Panini's Grammar (X1 to X9)	MS1800 MS1801 MS1802 MS1803 MS1804 MS1805 MS1806 – MS1815	HSMC (IKS)	2	2-0-0-0
7	Internship(Summer Semester)	IT4600	ELC	3	0-0-0-6
			Total	**21**	**14-0-8-6** **6+22**

Semester 8					**Total Credit: 12**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Major Project	IT5601	ELC	6	0-0-12-0 0-0-0-6
2	Elective-4(X1 to X99)	IT5501-IT5599	PEC	3	3-0-0-0 0-0-0-3*
3	Open Elective-2		OEC	3	3-0-0-0 0-0-0-3*
			Total	**12**	**6-0-12-0** **18**

*8th Semester courses may be allowed to join via MOOC/NPTEL etc. Major projects may be completed as Internship cum projects. MOOC/NPTEL courses start with level 4.

B.Tech. ECE

"Applicable with effect from 2023 admitted batch and onwards"

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Engineering Physics	AS1001	BSC	4	3-0-2-0
2	Linear Algebra	AS1002	BSC	4	3-1-0-0
3	Problem Solving with Programming	IT1001	ESC/VSEC	5	3-0-4-0
4	Fundamentals of Electrical & Electronics Engineering	EC1001	ESC	4	3-0-2-0
5	Technical Communication Skills	MS1001	HSMC (AEC)	2	1-0-2-0
6	Constitution of India	MS1002	HSMC (VEC)	1	1-0-0-0
	Universal Human Values	MS1003			
	Professional Ethics	MS1004			
	Art of Living	MS1005			
			Total	**20**	**14-1-10-0** **25**

Semester 2					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Electronic Workshop	EC1002	VSEC	1	0–0–2-0
2	Digital Logic Design with HDL	EC1008	PCC	3	2–0-2-0
3	Electronic Devices and Circuits	EC1004	ESC	3	2–0–2-0
4	Electronics Measurements and Instrumentations	EC1005	PCC	3	2-0-2-0
5	Data Structures and Algorithms	IT1003	ESC	4	3–0–2-0
6	Network Synthesis & Analog Filters	EC1007	PCC	3	2-1-0-0
7	Principles of Management	MS1006	HSMC(AEC)	2	1–0–2-0
8	Constitution of India	MS1002	HSMC(VEC)	1	1-0-0-0
	Environmental Studies	MS1007			
	Professional Ethics	MS1004			
	Physical Education(Sports)	MS1008			
			Total	**20**	**13-1-12-0** **26**

Exit: After successful completion of one year (first two semesters), a student may get an exit option as per ordinance. They need to do Skill Based Courses of 6 credits additional, in summer, before exit. Department will provide a list of such courses.

Semester 3					**Total Credit: 23**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Electromagnetic Field and Waves	EC2001	PCC	3	3–0–0-0
2	Signal and Systems	EC2002	PCC	4	3–1–0-0
3	Analog Electronics & Linear ICs	EC2003	PCC	4	3–0–2-0
4	Microprocessor Interface and Programming	EC2004	PCC	3	2–0–2-0
5	Biology for Engineers	AS1010	BSC	2	2-0-0-0
6	Multi-Disciplinary Minor-1	MS2501-MS2599 AS2501-AS2599 CS2501-CS2599	MDM	3	3–0–0-0
7	Principles of Economics	MS2001	HSMC (AEC)	2	2–0–0-0
	Introduction to Finance	MS2002			
8	**Community Services**		HSMC (CEA)	2	0-0-0-4
	NCC	MS1010			
	NSS	MS1011			
	Yoga	MS1012			
	Unnat Bharat Abhiyaan	MS1013			
	Ek Bharat Shreshtha Bharat	MS1014			
	NGO	MS1015			
	Prayas	MS1016			
	Other Courses	MS1017-MS1020			
			Total	**23**	**18-01-04-04** **28**

Semester 4					**Total Credit: 22**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Control Systems	EC2005	PCC	4	3–0–2-0
2	Analog Communication	EC2006	PCC	3	2–0-2-0
3	CMOS VLSI Design	EC2007	PCC	3	2–0–2-0
4	Probability and Statistics	AS2001	BSC	3	2–1–0-0
5	Antenna and Wave Propagation	EC2009	PCC	3	2-0-2-0
6	Integrated Circuit Technologies	EC2010	PCC	3	3-0-0-0
7	Multi-Disciplinary Minor-2	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
			Total	**22**	**17-1-08-0** **26**

Exit: After successful completion of 4 semesters, a student may get an exit option as per ordinance. They need to do ***Skill Based Courses of 6 credits***, additional, in summer, before exit. Department will provide a list of such courses.

Semester 5					**Total Credit: 22**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Digital Signal Processing	EC3001	PCC	4	3–0–2-0
2	Embedded System Design	EC3002	PCC	3	2–0–2-0
3	Microwave Engineering	EC3003	PCC	3	2–0–2-0
4	Digital Communication	EC3004	PCC	4	3–0–2-0
5	Program Elective-I A) Electrical Machines B) Advanced Computer Architectures C) AI & ML Techniques D) Solid State Devices E) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
6	Multi-Disciplinary Minor-3	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
7	Design Thinking and Innovation	EC3501	HSMC (AEC)	2	1-0-2-0
			Total	**22**	**17-0-10-0=27** **27**

Semester 6					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Communication & Networking	EC3005	PCC	3	2-0-2-0
2	Mobile and Wireless Communication	EC3006	PCC	3	2–0–2-0
3	Program Elective-II A) Power Electronics B) Testing & Verification C) Optical Communication D) Detection & Estimation Theory E) Physics of Nanoscale Devices F) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
4	Project	EC3559	VSEC	4	0-0-8-0
5	Multi-Disciplinary Minor-4	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
6	**Indian language(I1-I10)**		HSMC (AEC)	2	1-0-2-0
	Sanskrit	MS1401			
	(I2-I10)	MS1402 – MS1410			
	Foreign language(F1-F10)				
	German	MS1500			
	Japanese	MS1501			
	French	MS1502			
	(F4-F10)	MS1503-MS1510			
	Regional Language(R1-R10)				
	(R1-R10)	MS1600- MS1610			
			Total	**18**	**11-0-14-0** **24**

Exit: After successful completion of 6 semesters, a student any get an exit option after completion of the summer semester internship (3 credits) and additional 3 credit courses in summer.

I1 to I10, F1 to F10 and R1 to R10 will be decided by concerned department.

Summer Semester					**Total Credit: 3**
Sl. No.	Course Name	Code	Type	Credit	
1	Internship	EC4600	ELC	3	Credit will be added in VII Sem.

Note: Internship will be evaluated in the beginning of seventh semester. Its credit and grades will be reflected in the 7th Semester Grade Sheet.

Semester 7					**Total Credit: 21**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Program Elective-III A) Electrical Vehicles B) FPGA Architectures C) Image Processing & Image Vision D) Multiple Input-Multiple Output (MIMO) E) Low Power System Design F) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
2	Program Elective-IV A) Radar & Satellite Communication B) MEMS C) Speech Processing D) Emerging Nanoscale Devices E) 6G & THz Communication F) Any Other	EC5501-EC5599	PEC	3	3–0–0-0
3	Open Elective-I		OEC	3	3-0-0-0
4	Multi-Disciplinary Minor-5	MS2501-MS2599 AS2501-AS2599 CS2501- CS2599	MDM	3	3–0–0-0
5	History of Indian Civilizations	MS1800	HSMC (IKS)	2	2–0-0-0
	Kautilya's Arthashastra	MS1801			
	Vedic Mathematics	MS1802			
	Vedic Corpus	MS1803			
	Wisdom from the Ages	MS1804			
	Panini's Grammar	MS1805			
	X1 – X9	MS1806 – MS1815			
6	Internship (Summer Semester)	EC4600	ELC	3	0-0-0-6
7	Project	EC4501	ELC	4	0-0-8-0
			Total	**21**	**14-0-8-6** **28**

Semester 8					**Total Credit: 14**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Major Project	EC5601	ELC	8	0–0-16-0
2	Program Elective-V(X1-X199) A) IOT B) System on Chip C) Any Other	EC5501-EC5599	PEC	3	0–0–0-3
3	Open Elective-II		OEC	3	0–0–0-3
			Total	**14**	**0-0-16-6** **22**

*8th Semester courses may be allowed to join via MOOC/NPTEL etc.

LIST OF ELECTIVES

Total Credit: 21					
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Image and Video Processing	IT5504	PEC	3	3
2	Deep Learning	IT5505	PEC	3	3
3	Probabilistic Machine Learning and Graphical Model	IT5506	PEC	3	3
4	Optimization	IT5507	PEC	3	3
5	Deep Learning	IT5508	PEC	3	3
6	Robot Motion Control	IT5509	PEC	3	3
7	Foundations of Robotics	IT5510	PEC	3	3
8	Advanced Graphics & Animation	IT5511	PEC	3	3
9	Virtual Reality	IT5512	PEC	3	3
10	Software Design & Architecture	IT5513	PEC	3	3
11	Software Requirements and Estimation	IT5514	PEC	3	3
12	Software Testing and Quality Management	IT5515	PEC	3	3
13	Data Visualization	IT5516	PEC	3	3
14	Big Data Analytics	IT5517	PEC	3	3
15	Parallel and Distributed Computing	IT5518	PEC	3	3
16	Principles of Wireless Communications	IT5519	PEC	3	3
17	Cloud and Edge Computing	IT5520	PEC	3	3
18	Embedded Systems and IoT	IT5521	PEC	3	3
19	Information Security Laws and Regulations	IT5522	PEC	3	3
20	Network Security	IT5523	PEC	3	3
21	Cyber Physical System Security	IT5524	PEC	3	3
22	Visual Recognition	IT5525	PEC	3	3
23	Computer vision	IT5526	PEC	3	3

24	Natural Language Processing	IT5527	PEC	3	3
25	Database Security	IT5528	PEC	3	3
26	Blockchain Technology	IT5529	PEC	3	3
27	Remote Sensing and GIS	IT5530	PEC	3	3
28	Social Network Analysis	IT5531	PEC	3	3
29	Generative AI and LLMs	IT5532	PEC	3	3
30	Large Language Model Conditioned Human-Robot Interactions	IT5533	PEC	3	3
31	Distributed Systems	IT5534	PEC	3	3
32	Optimization	IT5535	PEC	3	3
33	Probabilistic Graphical Models	IT5536	PEC	3	3
34	Cyber Security and Digital Forensics	IT5537	PEC	3	3
35	OMICS	AS5501	PEC	3	3
36	Data Analytics Fundamentals for Biology	AS5502	PEC	3	3
37	Scripting and Computer Environments	AS5503	PEC	3	3
38	Next-Generation Sequencing Tools and Algorithms	AS5504	PEC	3	3
39	Data Engineering for Molecular Structure Prediction	AS5505	PEC	3	3
40	Circuits and Instrumentation for Biomedical Engineering	AS5506	PEC	3	3
41	Biomechanics	AS5507	PEC	3	3
42	Biosignal Processing	AS5508	PEC	3	3
43	Mathematics and Statistics for Biology	AS5509	PEC	3	3
44	Molecular Biology	AS5510	PEC	3	3
45	Anatomy & Physiology	AS5511	PEC	3	3
46	Advanced Medical Instrumentation	AS5512	PEC	3	3
47	Biomedical Imaging	AS5513	PEC	3	3
48	Solid State Devices	EC5503	PEC	3	3

49	Testing and Verification	EC5505	PEC	3	3
50	Analog Integrated Circuit Design	EC5506	PEC	3	3
51	Advanced Digital Communication	EC5507	PEC	3	3
52	Statistical Signal Analysis	EC5508	PEC	3	3
53	Radiating Systems	EC5509	PEC	3	3
54	Introduction to Machine Learning	EC5510	PEC	3	3
55	Principles of Wireless Communications	EC5511	PEC	3	3
56	Recent Advances in Machine Learning	EC5512	PEC	3	3
57	Hardware Design Methodology	EC5513	PEC	3	3
58	Physics of Nanoscale Devices	EC5514	PEC	3	3
59	Radar & Satellite Communication	EC5515	PEC	3	3
60	Micro-electromechanical Systems	EC5516	PEC	3	3
61	Speech Processing	EC5517	PEC	3	3
62	Emerging Nanoscale Devices	EC5518	PEC	3	3
63	6G & THz Communication	EC5519	PEC	3	3
64	RF Integrated Circuit Design	EC5520	PEC	3	3

Multidisciplinary Minor

Entrepreneurship & Innovation				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	MS2501	Fundamentals of Entrepreneurship	3	2-0-2-0
IV	MS2502	Social Entrepreneurship	3	2-0-2-0
V	MS2503	Entrepreneurial Finance	3	2-1-0-0
VI	MS2504	Innovation Management	3	2-0-2-0
VII	MS2505	Managing Corporate Entrepreneurship	3	2-0-2-0
		Total	**15**	

Economics & Finance for Engineers				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	MS2506	Indian Economics	3	2-0-2-0
IV	MS2507	Money and Banking	3	2-0-2-0
V	MS2508	Economics of Business Environment	3	2-1-0-0
VI	MS2509	Start-up Economics	3	2-0-2-0
VII	MS2510	Digital Economics	3	2-0-2-0
		Total	15	

Science of Happiness				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	CS2501	Introduction to Science of Happiness	3	2-0-2-0
IV	CS2502	Understanding Domains of Happiness	3	2-0-2-0
V	CS2503	Happiness Indices	3	2-1-0-0
VI	CS2504	Assessment of happiness	3	2-0-2-0
VII	CS2505	Independent Study of Science of Happiness	3	2-0-2-0
		Total	**15**	

Biological Data Analytics				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2501	Proteomics and Genomics	3	2-0-2-0
IV	AS2502	Next Generation Sequencing	3	2-0-2-0
V	AS2503	Cheminformatics for Engineers	3	2-1-0-0
VI	AS2504	Systems Biology and Modeling	3	2-0-2-0
VII	AS2505	Molecular Structure Prediction	3	2-0-2-0
		Total	**15**	

Medical Diagnostics and Therapeutic Technology				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2506	Basics of Human Anatomy & Physiology	3	2-0-2-0
IV	AS2507	Biomedical Instrumentation	3	2-0-2-0
V	AS2508	Bio-MEMs and Nanotechnology	3	2-1-0-0
VI	AS2509	Medical Imaging	3	2-0-2-0
VII	AS2510	Tissue engineering and Gene therapy	3	2-0-2-0
		Total	15	

Mathematical Analysis				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2511	Real Analysis	3	3-0-0-0
IV	AS2512	Introduction to Topology	3	3-0-0-0
V	AS2513	Differential Geometry of Curves and Surfaces	3	3-0-0-0
VI	AS2514	Measure Theory	3	3-0-0-0
VII	AS2515	Functional Analysis	3	3-0-0-0
		Total	15	

Frontiers in Physics				
Semester	**Course Code**	**Course Title**	**Credits**	**Hours**
				L-T-P-S
III	AS2516	Light Matter Interaction	3	2-1-0-0
IV	AS2517	Physics of Space and Time	3	2-1-0-0
V	AS2518	Magnetic Materials and Applications	3	2-1-0-0
VI	AS2519	Quantum Materials & Devices	3	2-1-0-0
VII	AS2520	Green Energy Physics	3	2-1-0-0
		Total	15	

M.Tech. IT- Machine Learning and Intelligent Systems (MLIS)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Image and Video Processing	IT4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0** / **23**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Deep Learning	IT4005	PCC	4	3-0-2-0
2	Probabilistic Machine Learning and Graphical Model	IT4006	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Optimization	IT4007	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** / **23**

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** / **28**

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Machine Learning and Intelligent Systems (MLIS)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Image and Video Processing	IT4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**15-0-10-0** / **25**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Deep Learning	IT4005	PCC	4	3-0-2-0
2	Probabilistic Machine Learning and Graphical Model	IT4006	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**14-1-10-0** / **25**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Optimization	IT4007	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	IT5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. IT- Robotics and Machine Intelligence (RMI)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Image and Video Processing	IT4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0**
					23

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Deep Learning	IT4005	PCC	4	3-0-2-0
2	Robot Motion Control	IT4020	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0**
					22

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Foundations of Robotics	IT4030	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0**
					23

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0**
					28

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Robotics and Machine Intelligence (RMI)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Image and Video Processing	IT4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**15-0-10-0** (**25**)

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Deep Learning	IT4005	PCC	4	3-0-2-0
2	Robot Motion Control	IT4020	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**14-1-10-0** (**25**)

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Foundations of Robotics	IT4030	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	IT5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-04-0** (**13**)

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. IT- Human-Computer Interaction (HCI)

Semester 1					Total Credit: 18
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Image and Video Processing	IT4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0** (**23**)

Semester 2					Total Credit: 17
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Deep Learning	IT4005	PCC	4	3-0-2-0
2	Advanced Graphics & Animation	IT4040	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** (**22**)

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					Total Credit: 16
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Virtual Reality	IT4041	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-2-10-0** (**21**)

Semester 4					Total Credit: 15
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** (**28**)

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Human-Computer Interaction (HCI)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Image and Video Processing	IT4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**15-0-10-0** / **25**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Deep Learning	IT4005	PCC	4	3-0-2-0
2	Advanced Graphics & Animation	IT4040	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**14-1-10-0** / **25**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Virtual Reality	IT4040	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	IT5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. IT- Software Engineering (SE)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Data Analytics	IT4008	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0** / **23**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Software Design & Architecture	IT4400	PCC	4	3-0-2-0
2	Software Requirements and Estimation	IT4401	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Software Testing and Quality Management	IT4500	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** / **23**

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** / **28**

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Software Engineering (SE)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Data Analytics	IT4008	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**15-0-10-0** / **25**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Software Design & Architecture	IT4400	PCC	4	3-0-2-0
2	Software Requirements and Estimation	IT4401	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Software Testing and Quality Management	IT4500	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	IT5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. IT- Data Engineering (DE)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Data Analytics	IT4008	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0** / **23**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Visualization	IT4601	PCC	4	3-0-2-0
2	Big Data Analytics	IT4250	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Parallel and Distributed Computing	IT4522	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** / **23**

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** / **28**

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Data Engineering (DE)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Machine Learning	IT4003	PCC	4	3-0-2-0
4	Data Analytics	IT4008	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**15-0-10-0** / **25**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Visualization	IT4600	PCC	4	3-0-2-0
2	Big Data Analytics	IT4250	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Parallel and Distributed Computing	IT4500	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	IT5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. IT- Wireless Communication and Computing (WCC)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Cryptography	IT4009	PCC	4	3-0-2-0
4	Networking Concepts	IT4010	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0** (**23**)

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Principles of Wireless Communications	IT4700	PCC	4	3-0-2-0
2	Cloud and Edge Computing	IT4701	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** (**22**)

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Embedded Systems and IoT	IT4800	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** (**23**)

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** (**28**)

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Wireless Communication and Computing (WCC)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Cryptography	IT4009	PCC	4	3-0-2-0
4	Networking Concepts	IT4010	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**15-0-10-0** / **25**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Principles of Wireless Communications	IT4700	PCC	4	3-0-2-0
2	Cloud and Edge Computing	IT4701	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Embedded Systems and IoT	IT4800	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	IT5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. IT- Cyber Laws and Information Security (CLIS)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Cryptography	IT4009	PCC	4	3-0-2-0
4	Networking Concepts	IT4010	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**13-0-10-0** / **23**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Information Security Laws and Regulations	IT4900	PCC	4	3-0-2-0
2	Network Security	IT4901	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Cyber Physical System Security	IT4950	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	Thesis- Part 1	IT6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** / **23**

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	IT6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** / **28**

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Cyber Laws and Information Security (CLIS)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Mathematics for IT	IT4001	PCC	4	3-0-2-0
2	Advanced Programming Practices	IT4002	PCC	4	2-0-4-0
3	Introduction to Cryptography	IT4009	PCC	4	3-0-2-0
4	Networking Concepts	IT4010	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**15-0-10-0** / **25**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Information Security Laws and Regulations	IT4900	PCC	4	3-0-2-0
2	Network Security	IT4901	PCC	4	3-0-2-0
3	Elective - 1	IT5501-IT5599	PEC	3	3-0-0-0
4	Project	IT5610	ELC	4	0-1-6-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-1-10-0** / **22**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Cyber Physical System Security	IT4950	PCC	3	3-0-0-0
2	Elective – 2	IT5501-IT5599	PEC	3	3-0-0-0
3	Elective - 3	IT5501-IT5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	IT5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. Applied Science -Bio Informatics (BI)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	OMICS	AS4001	PCC	4	3-0-2-0
2	Data Analytics Fundamentals for Biology	AS4002	PCC	4	3-1-0-0
3	Scripting and Computer Environments	AS4003	PCC	4	2-0-4-0
4	Data Structure and Algorithms	AS4004	PCC	4	2-0-4-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**12-1-10-0**
					23

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Engineering for Molecular Structure Prediction	AS4101	PCC	4	3-0-2-0
2	Next-Generation Sequencing Tools and Algorithms	AS4103	PCC	4	3-0-2-0
3	Elective - 1	AS5501-AS5599	PEC	3	3-0-0-0
4	Project	AS5610	ELC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0**
					23

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	AS5501-AS5599	PEC	3	3-0-0-0
2	Elective – 3	AS5501-AS5599	PEC	3	3-0-0-0
3	Elective - 4	AS5501-AS5599	OEC	3	3-0-0-0
4	Thesis- Part 1	AS6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0**
					23

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	AS6002	ELC	15	0-0-30-0
			Total	**15**	**0-0-30-0**
					30

M.Tech-PhD. Applied Science -Bio Informatics (BI)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	OMICS	AS4001	PCC	4	3-0-2-0
2	Data Analytics Fundamentals for Biology	AS4002	PCC	4	3-1-0-0
3	Scripting and Computer Environments	AS4003	PCC	4	2-0-4-0
4	Data Structure and Algorithms	AS4004	PCC	4	2-0-4-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**14-1-10-0** / **25**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Data Engineering for Molecular Structure Prediction	AS4101	PCC	4	3-0-2-0
2	Next-Generation Sequencing Tools and Algorithms	AS4103	PCC	4	3-0-2-0
3	Elective - 1	AS5501-AS5599	PEC	3	3-0-0-0
4	Project	AS5610	ELC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0** / **23**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	AS5501-AS5599	PEC	3	3-0-0-0
2	Elective – 3	AS5501-AS5599	PEC	3	3-0-0-0
3	Elective - 4	AS5501-AS5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	AS5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance.

M.Tech. Applied Science –Bio-Medical Engineering (BME)

Semester 1					Total Credit: 18
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Circuits and Instrumentation for Biomedical Engineering	AS4500	PCC	4	3-0-2-0
2	Biomechanics	AS4501	PCC	4	3-0-2-0
3	Core courses to be chosen from one of the Basket 1/2		PCC	4	3-0-2-0
4	Core courses to be chosen from one of the Basket 1/2		PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELC	2	2-0-0-0
			Total	**18**	**14-0-08-0** **22**

Basket 1: Medical/B.Pharma. /Pharmacology/Biotechnology/M.Sc. in Biology or Life Sciences/Applied Chemistry					
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Biosignal Processing	AS4530	PCC	4	3-0-2-0
2	Mathematics and Statistics for Biology	AS4531	PCC	4	3-1-0-0

Basket 2: Engineering/Technology/Instrumentation/Electronics/IT/CS/Physics/Applied Physics					
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Molecular Biology	AS4550	PCC	4	3-0-2-0
2	Anatomy & Physiology	AS4551	PCC	4	3-0-2-0

Semester 2					Total Credit: 17
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Advanced Medical Instrumentation	AS4200	PCC	4	3-0-2-0
2	Biomedical Imaging	AS4201	PCC	4	3-0-2-0
3	Elective - 1	AS5501-AS5599	PEC	3	3-0-0-0
4	Project	AS5610	ELC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0** **23**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	AS5501-AS5599	PEC	3	3-0-0-0
2	Elective – 2	AS5501-AS5599	PEC	3	3-0-0-0
3	Elective - 4	AS5501-AS5599	OEC	3	3-0-0-0
4	Thesis- Part 1	AS6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** **23**

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	AS6002	ELC	15	0-0-30-0
			Total	**15**	**0-0-30-0** **30**

MTECH ECE- Microelectronics (MI)

Semester 1					Total Credit: 18
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Digital System Design	EC4001	PCC	4	3-0-2-0
2	VLSI Technology	EC4002	PCC	4	3-0-2-0
3	Solid State Devices	EC4003	PCC	4	3-0-2-0
4	Embedded System Design	EC4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELE	2	2-0-0-0
			Total	**18**	**14-0-08-0**
					22

Semester 2					Total Credit: 17
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Testing and Verification	EC4005	PCC	4	3-0-2-0
2	Analog Integrated Circuit Design	EC4006	PCC	4	3-0-2-0
3	Elective - 1	EC5501-EC5599	PEC	3	3-0-0-0
4	Project	EC5610	PEC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0**
					23

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					Total Credit: 16
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	EC5501-EC5599	PEC	3	3-0-0-0
2	Elective – 3	EC5501-EC5599	PEC	3	3-0-0-0
3	Elective - 4	EC5501-EC5599	OEC	3	3-0-0-0
4	Thesis- Part 1	EC6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0**
					23

Semester 4					Total Credit: 15
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	EC6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0**
					28

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. IT- Microelectronics (MI)

Semester 1					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Digital System Design	EC4001	PCC	4	3-0-2-0
2	VLSI Technology	EC4002	PCC	4	3-0-2-0
3	Solid State Devices	EC4003	PCC	4	3-0-2-0
4	Embedded System Design	EC4004	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELE	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**16-0-08-0** / **24**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Testing and Verification	EC4005	PCC	4	3-0-2-0
2	Analog Integrated Circuit Design	EC4006	PCC	4	3-0-2-0
3	Elective - 1	EC5501-EC5599	PEC	3	3-0-0-0
4	Project	EC5610	PEC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0** / **23**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 11**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	EC5501-EC5599	PEC	3	3-0-0-0
2	Elective – 3	EC5501-EC5599	PEC	3	3-0-0-0
3	Elective - 4	EC5501-EC5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	EC5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance

M.Tech. ECE- Communication Engineering (CE)

Semester 1					**Total Credit: 18**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Advanced Digital Communication	EC4075	PCC	4	3-0-2-0
2	Statistical Signal Analysis	EC4076	PCC	4	3-0-2-0
3	Radiating Systems	EC4077	PCC	4	3-0-2-0
4	Introduction to Machine Learning	EC4078	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELE	2	2-0-0-0
			Total	**18**	**14-0-08-0** / **22**

Semester 2					**Total Credit: 17**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Principles of Wireless Communications	EC4035	PCC	4	3-0-2-0
2	Recent Advances in Machine Learning	EC4036	PCC	4	3-0-2-0
3	Elective - 1	EC5500-EC5599	PEC	3	3-0-0-0
4	Project	EC5610	PEC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0** / **23**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 16**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	EC5501-EC5599	PEC	3	3-0-0-0
2	Elective – 3	EC5501-EC5599	PEC	3	3-0-0-0
3	Elective - 4	EC5501-EC5599	OEC	3	3-0-0-0
4	Thesis- Part 1	EC6001	ELC	7	0-0-14-0
			Total	**16**	**09-0-14-0** / **23**

Semester 4					**Total Credit: 15**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Thesis- Part 2	EC6002	ELC	15	0-2-26-0
			Total	**15**	**0-2-26-0** / **28**

"Applicable with effect from 2023 admitted batch and onwards"

M.Tech-PhD. ECE- Communication Engineering (CE)

Semester 1					Total Credit: 20
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Advanced Digital Communication	EC4075	PCC	4	3-0-2-0
2	Statistical Signal Analysis	EC4076	PCC	4	3-0-2-0
3	Radiating Systems	EC4077	PCC	4	3-0-2-0
4	Introduction to Machine Learning	EC4078	PCC	4	3-0-2-0
5	Research Methodology & IPR	AS4100	ELE	2	2-0-0-0
6	Research Methodology-2	AS4200	ELC	2	2-0-0-0
			Total	**20**	**16-0-08-0** / **24**

Semester 2					Total Credit: 17
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Principles of Wireless Communications	EC4035	PCC	4	3-0-2-0
2	Recent Advances in Machine Learning	EC4036	PCC	4	3-0-2-0
3	Elective - 1	EC5500-EC5599	PEC	3	3-0-0-0
4	Project	EC5610	PEC	4	0-0-8-0
5	HSMC	MS1102-MS1110	HSMC	2	2-0-0-0
			Total	**17**	**11-0-12-0** / **23**

Exit: After successful completion of one year (first two semesters), students may get ***PG Diploma.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					Total Credit: 11
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Elective – 2	EC5501-EC5599	PEC	3	3-0-0-0
2	Elective – 3	EC5501-EC5599	PEC	3	3-0-0-0
3	Elective - 4	EC5501-EC5599	OEC	3	3-0-0-0
4	***Independent Study*** *as advised by the Supervisor Suitable Title to be communicated for Grade Card purposes.*	EC5001	ELC	2	0-0-4-0
			Total	**11**	**09-0-4-0** / **13**

M.Tech-Ph.D : After the end of II Semester and passing all courses, the M.Tech-PhD student moves into the Ph.D Section of the Degree and will be henceforth governed by the Ph.D ordinance

MBA- Management Studies

Semester 1					Total Credit: 20
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Financial Statements and Analysis	MS4101	PCC	3	2-1-0-0
2	Business Statistics	MS4102	PCC	3	2-0-2-0
3	Research Methodology	MS4103	PCC	3	3-0-0-0
4	Economics	MS4104	PCC	3	3-0-0-0
5	Management Thought and Environment	MS4105	PCC	3	2-0-2-0
6	IT Infrastructure & Services Mgt.	MS4106	PCC	3	2-0-2-0
7	Organizational Behavior	MS4107	PCC	2	2-0-0-0
			Total	**20**	**16-1-06-0** / **22**

Semester 2					Total Credit: 20
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Corporate Finance	MS4108	PCC	3	2-1-0-0
2	Production & Operations Management	MS4109	PCC	3	2-0-2-0
3	Operation Research	MS4110	PCC	3	2-0-2-0
4	Human Resource Management	MS4111	PCC	3	2-0-2-0
5	Marketing Management	MS4112	PCC	3	2-0-2-0
6	Database Management Systems	MS4113	PCC	3	2-0-2-0
7	Entrepreneurship Development	MS4114	PCC	2	1-0-2-0
			Total	**20**	**13-1-12-0** / **26**

Exit: After successful completion of one year (first two semesters), students may get ***Diploma in Business Administration.*** They need to earn 6 credits additional, in summer, before exit.

Semester 3					**Total Credit: 20**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Strategic Management	MS5201	PCC	3	2-0-2-0
2	Business Continuity Plan & DRP	MS5202	PCC	3	2-0-2-0
3,4	Two courses to be chosen from one of the Baskets 1/2/3/4/5/6	MS5501-MS5599	PEC	3 3	2-0-2-0 2-0-2-0
5,6	Two courses to be chosen from one of the Baskets 1/2/3/4/5/6	MS5501-MS5599	PEC	3 3	2-0-2-0 2-0-2-0
7	Summer Internship	MS6001	PEC	2	0-0-0-4
			Total	**20**	**12-0-12-0** **24**
Basket 1: Marketing Management					
Basket 2: Human Resource Management					
Basket 3: Financial Management					
Basket 4: IT					
Basket 5: Operation Management					
Basket 6: Entrepreneurship Development					

Semester 4					**Total Credit: 22**
Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
1	Digital Transformation	MS5203	PCC	3	2-0-2-0
2	Product Management	MS5204	PCC	3	2-0-2-0
3,4	Two courses to be chosen from one of the Baskets 1/2/3/4/5/6	MS5501-MS5599	PEC	3 3	2-0-2-0 2-0-2-0
5,6	Two courses to be chosen from one of the Baskets 1/2/3/4/5/6	MS5501-MS5599	PEC	3 3	2-0-2-0 2-0-2-0
7	Master Project	MS6002	PEC	4	0-0-0-8
			Total	**22**	**16-0-4-8** **28**
Basket 1: Marketing Management					
Basket 2: Human Resource Management					
Basket 3: Financial Management					
Basket 4: IT					
Basket 5: Operation Management					
Basket 6: Entrepreneurship Development					

Sl. No.	Course Name	Code	Type	Credit	Hours L-T-P-S
Finance Basket					
1	Security Analysis and A Portfolio Management	MS5501	PEC	3	3-0-0-0
2	International Financial Management	MS5502	PEC	3	3-0-0-0
3	Strategic Cost Management	MS5503	PEC	3	3-0-0-0
4	Behaviour Finance	MS5504	PEC	3	3-0-0-0
5	Management of Banking and Financial Institution	MS5505	PEC	3	3-0-0-0
6	Financial Technology	MS5506	PEC	3	3-0-0-0
7	Financial Derivatives and Risk Management	MS5507	PEC	3	3-0-0-0
8	Project Appraisal and Financing	MS5508	PEC	3	3-0-0-0
Operation Basket					
1	Strategic Sourcing and Logistic Management	MS5509	PEC	3	3-0-0-0
2	Supply Chain Management	MS5510	PEC	3	3-0-0-0
3	Project Management	MS5511	PEC	3	3-0-0-0
4	Knowledge Management	MS5512	PEC	3	3-0-0-0
5	Total Quality Management and Six Sigma	MS5513	PEC	3	3-0-0-0
6	Sustainable and Global Supply Chain	MS5514	PEC	3	3-0-0-0
7	Service Operations Management	MS5515	PEC	3	3-0-0-0
8	Advanced Operations Research	MS5516	PEC	3	3-0-0-0
IT Basket					
1	FIS and IT Audit	MS5517	PEC	3	3-0-0-0
2	IT Risk Compliance	MS5518	PEC	3	3-0-0-0
3	IT Governance & Control	MS5519	PEC	3	3-0-0-0
4	Cyber Security Strategy and Implementation	MS5520	PEC	3	3-0-0-0
5	Cloud Services & Security	MS5521	PEC	3	3-0-0-0

6	Search Engine Optimization	MS5522	PEC	3	3-0-0-0
7	Risk Vulnerability and Physical Assessment	MS5523	PEC	3	3-0-0-0
8	Expert System Design and Applications	MS5524	PEC	3	3-0-0-0
9	System Analysis and Design and Software Engineering	MS5525	PEC	3	3-0-0-0
10	Business Intelligence	MS5526	PEC	3	3-0-0-0
Marketing Basket					
1	Advertising and Sales Promotion	MS5527	PEC	3	3-0-0-0
2	Digital Marketing	MS5528	PEC	3	3-0-0-0
3	Marketing of Services	MS5529	PEC	3	3-0-0-0
4	Retail Operations and Management	MS5530	PEC	3	3-0-0-0
5	International Marketing	MS5531	PEC	3	3-0-0-0
6	Strategic Marketing	MS5532	PEC	3	3-0-0-0
7	Business Marketing and Key Account Management	MS5533	PEC	3	3-0-0-0
8	Consumer Behaviour	MS5534	PEC	3	3-0-0-0
9	Marketing Research	MS5535	PEC	3	3-0-0-0
10	Data Driven Marketing	MS5536	PEC	3	3-0-0-0
HR Basket					
1	Emotional Intelligence and Leadership	MS5537	PEC	3	3-0-0-0
2	Employer Brand Building	MS5538	PEC	3	3-0-0-0
3	Strategic HRM	MS5539	PEC	3	3-0-0-0
4	Creativity and Innovation	MS5540	PEC	3	3-0-0-0
5	Training and Development	MS5541	PEC	3	3-0-0-0
Entrepreneur Basket					
1	Entrepreneurship Development	MS5542	PEC	3	3-0-0-0
2	Innovation Development	MS5543	PEC	3	3-0-0-0
3	Social Entrepreneurship	MS5544	PEC	3	3-0-0-0
4	Entrepreneurial Finance	MS5545	PEC	3	3-0-0-0

5	Project Appraisal and Management	MS5546	PEC	3	3-0-0-0
6	Managing Corporate Entrepreneurship	MS5547	PEC	3	3-0-0-0

B.TECH- IT

Applicable with effect from 2023 admitted batch and onwards

Engineering Physics (AS1001)

Objective: Students will be able Demonstrate ability to collect, process, and analyze scientific data, display critical thinking skills in applying physics knowledge in the experimental process.

Course outcome

At the end of this course, Students will be able to

- To analyze dynamics of system of particles for applications in Physics and Engg.
- Identify, formulate and solve engineering problems requiring principles of physics
- Gain knowledge about modern physics and quantum mechanics
- Apply quantum physics to understand solid state materials
- Design & conduct experiments, analyze & interpret data

Classical Mechanics

Symmetry and conservation laws, Fermat's principle, Principle of least action, Euler Lagrange equations and its applications, Degrees of freedom, Constraints and constraint forces, Generalized momentum, Concept of phase space, Hamiltonian.

Quantum Mechanics

De Broglie's hypothesis, wave function and wave packets, phase and group velocities. Schrödinger Equation. Probabilities and Normalization, Eigenvalues and eigen functions. Infinite potential well and energy quantization. Finite square well, potential steps and barriers - notion of tunneling, band structure of solid.

Solid State Physics

Energy Bands, Carrier transport in semiconductor, mobility and resistivity, electron effective mass, Density of states, Fermi-Dirac distribution function, intrinsic carrier concentration, Mechanism of carrier scattering, Einstein relationship.

Text Books

- Classical Mechanics; H. Goldstein, C. Poole, J. Safko; Pearson Education, Third Edition (2002)
- Modern Physics by A. Beiser; McGraw-Hill Higher Education, Sixth Edition (2003)
- Introduction to Quantum Mechanics by D. J. Griffiths; Pearson Education, Second Edition (2005)
- Introduction to Solid State Physics by C. Kittel; Wiley Students Edition, (2005)
- Physics of semiconductor devices, S M Sze, John Wiley & Sons, 2006

Reference Books

- Theoretical Mechanics by M. Spiegel; McGraw Hill Education, 2017
- Feynman Lectures of Physics Vol-1 and Vol-3; The Millenium Edition, Pearson (2012)
- Quantum Physics for Atoms, Molecules, Solids, Nuclei and Particles by R. Eisberg and R. Resnick; 2nd Edition, New Delhi Wiley (2012)

Linear Algebra (AS1002)

Objective: Students will be able to solve linear equations & develop understanding of vector spaces, linear transformations, Eigen value, diagonalization and orthogonalization, least square solutions and singular value decomposition etc

Course Outcome

Students will be able to

- Understand the concept of matrices, their properties & solve linear equations
- Understand basic concepts of vector spaces, subspace, linear dependence etc
- Calculate the rank-nullity of a matrix / linear map, eigenvalues, and eigenvectors.
- Apply the Gram-Schmidt process, Find the SVD, Jordan Canonical form .
- Apply concepts of linear algebra to various applications.

Matrices and Vector Spaces

System of linear equation, Gauss elimination method, Elementary matrices, Invertible matrices, Gauss-Jordan method, Determinant, Cramer's rule, Vector spaces, Linearly independence and independence, Basis, Dimension.

Linear transformation & Diagonalizability

Linear transformation, Representation of linear maps by matrices, Rank-Nullity theorem, Rank of a matrix, Row and column spaces, Solution space of a system of homogeneous and non-homogeneous equations, Eigenvalue, eigenvector, Cayley-Hamilton theorem, Diagonalizability, minimal polynomial

Inner product space

Inner product space, Cauchy-Schwarz inequality, Orthogonal basis, Gram-Schmidt orthogonalization process, Orthogonal projection, Spectral theorem.

SVD & Jordan Canonical Form

Positive, negative, and semi-definite matrices. Decomposition of the matrix in terms of projections, Strategy for choosing the basis for the four fundamental subspaces, Least square solutions and fittings, Singular values, Primary decomposition theorem, and Jordan canonical form.

Text/Reference Books

- K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Pearson (2015).
- Gilbert Strang, Introduction to Linear Algebra, 4th Edition, Cambridge Press (2009).
- S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).
- S. Lang, Introduction to Linear Algebra, 2nd Edition, Springer (2012).

Problem Solving with Programming (IT1001)

Objective: Students will be able to understand programming language (in this case C language), develop a problem-solving approach from programmer's perspective.

Course Outcome

Students will be able to:

- break down complex real-world problems into smaller, manageable subproblems and develop logical approaches for solving them through programming.
- learn to debug code, identify and fix logical errors, and write test cases.
- develop a systematic approach to problem-solving, logical reasoning, and iterative refinement.

Introduction to Computers & Demo

Computer hardware, Computer Networks, IP Address, Proxy, Gateway, Operating Systems, Disk/Directory/Files system, Application Software. Professional Ethics.

Programming Basics: Structure of a simple C program, Constants and Variables, Basic Data Types, Precedence and Associativity, implicit and explicit type conversion, Selection Statements, Loop Structures

Functions and Arrays: User-defined functions, function definition, Storage class and Scope, Macros, Nested, and Recursive Functions, One Dimensional arrays, Passing Arguments, Two and higher Dimensional Arrays, Strings, String Library Functions

Pointer and Structure: Addresses and Pointers, Structures, Dynamic Memory Allocation, Linked List, Stack, Queue. Data Files.

Text Books

- "Engineering Problem Solving with C", Delores M. Etter, Fourth Edition, 2012, Pearson.
- "C: How to Program", Paul Deitel and Harvey Deitel, Ninth Edition, 2022, Pearson.

Reference Books

- "Computer Systems: A Programmer's Perspective", Randal E Bryant and David R O'Hallaron, Third Edition, 2015, Pearson.
- "Problem Solving and Program Design in C", Jeri R. Hanly and Elliot B. Koffman, Eighth Edition, 2015, Pearson.
- "Programming in C", Brian Kernighan and Dennis Ritchie, Second Edition, 2015, Pearson.

Fundamentals of Electrical and Electronics Engineering (EC1001)

Objective: Students will be able to understand the fundamental concepts of electrical and electronics engineering.

Course Outcome
Students will be able to:

- Understand working principles of basic electrical and electronic devices and circuits.
- Design basic electronic circuits

Introduction
Basic physical laws, circuit elements, KVL, KCL, Network Theorems

Transients
R-L, R-C, R-L-C, Sinusoidal Steady State, Real/Reactive Power, Three Phase,

Transformers/AC/DC machines
Working Principles of Transformers/AC/DC machines

Semiconductors
Semiconductors, Band Diagram, n-type and p-type semiconductor, junction diode, diode biasing, Zener diode, DC Power supply

Transistors
Introduction to Bipolar Junction Transistor, MOS Capacitor, Introduction to Operational Amplifier, Schmitt Trigger, Multivibrator, Oscillators

Text Book

- Microelectronic Circuits SEDRA/SMITH 7th Edition Oxford University Press
- Fundamentals of Electrical Engineering, Leonard S Bobrow, 2nd Edition, Oxford Press.
- Fundamentals of Electrical Engineering and Electronics, B L Thereja, S Chand Press.

References

- Network Analysis, M E Van Valkenberg, 3rd Edition, PHI, 2000
- Linear Circuit Analysis: Time, Domain, Phasor and Laplace Transform Approaches, R A DeCarlo and M Lin, 2nd Edition, Oxford University Press, 2000

Technical Communication Skills (MS1001)

Objective: Students will be able to enhance and polish communication skills which will formally help them to be effective professionals by understanding importance of effective communication, presentation and designing of work.

Course Outcome
Students will be able to:

- Speak and participate in GD
- Write technical letters, CV, product development plans etc

Introduction
Introduction to types of communication, Lab sessions and mock presentation pertaining to Communication Styles, Content Management and Delivery Making Effective Public presentations, Speech and diction correction and counseling

Formal communication
Written communication, Problems and solutions Lab sessions will have exposure to: Cover letter, CV preparation Group discussion and Personal Interview Report writing and Proposal development plan, Interview: types and techniques SWOT Analysis.

Reference Books

- Winning at Interviews by Edgar Thorpe Books on Technical Writing

Constitution of India (MS1002)

Objective: Students will be able to understand the Fundamental features of the Indian Constitution, Union Government, Rights and Duties, Statutory Institutions.

Course Outcome
Students will be able to:

- Understand Indian Constitution, its composition and functions, Union and state Government
- Understand Rights and Duties, Statutory Institutions etc

Introduction
Evolution of the Indian Constitution, Acts, Fundamental features of the Indian Constitution, Union, State and Local Government.

Rights and Duties
Fundamental Rights and Duties, Directive Principles, Relation between Federal and Provincial units: Union-State relations, Administrative, legislative& Financial, Inter-State Council, NITI Ayog, Finance Commission of India, Union List, State List, Concurrent List, Statutory Institutions: Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

Reference

- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi
- Subhash Kashyap, Our Parliament, National Book Trust, New Delhi
- Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi

Universal Human Values (MS1003)

Objective: Students will be able to understand the human values.

Course Outcome
Students will be able to:

- Understand the importance of human values, family, society, nature etc.
- Develop commitment and courage to act.

Introduction
Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

Self Reflection
Right understanding Strengthening of self-reflection, Development of commitment and courage to act, Method to fulfill the human aspirations: understanding and living in harmony at various levels.

Reference

Professional Ethics (MS1004)

Objective: Students will be able to understand the awareness on Engineering Ethics and Human Values.

Course Outcome
Students will be able to:

- Understand social responsibility of an engineer etc.
- To appreciate ethical dilemma while discharging duties in professional life.

Values
Human Values Morals, Integrity, Work Ethics, Honesty, Courage, Empathy etc. Kohlberg's theory, Gilligan's theory, Models of Professional Roles.

Ethics
Codes of ethics, Challenger case study, Safety and Risk, The Three Mile Island And Chernobyl Case Studies, global issues, moral leadership

Reference

- Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.
- Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
- Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
- Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
- John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

Youth Empowerment and Skills (MS 1005)

Objective: To equip students with practical tools and techniques that will make them more creative, efficient, confident, clear-minded, stress-free, joyful and energetic

Course Outcome
Students will be able to:

- learn challenges and will learn group processes, talks, presentations and hands-on learning methodology that helps students to enhance their lives.
- Participate in Group discussions and role-plays to inculcate life-skills and human values
- Yoga Asanas and Pranayama to increase concentration & build confidence
- Breathing techniques (like the world-renowned and well-researched Sudarshan KriyaTM)
- Talks and Presentations to bring out attitudinal and behavioral changes towards achieving student excellence.

Personality Development
Personality Development Self-awareness, Emotional Intelligence / Coping with Emotions, Mind Management, Coping with Stress, Health and Nutrition, Social Adaptability and Effectiveness Effective Communication Skills, Interpersonal Relationship Skills, Lifestyle and Environment

Ethics
Ethics, Morality and Integrity, Time Management and Goal Setting, Professional Skills, Active Learning and Effective Learning Strategies, Decision Making

Reference

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Computer Organization and Architecture (IT1002)

Objective: To make student learn the basic concepts of computer architecture and organization, and understand the key skills of constructing cost-effective computer systems**.**

Course Outcome

- To understand the basic operations of computing hardware interface and system-level programming, compilers, assemblers, instruction sets etc.
- Understand merits/demerits for performance, design process of a computer, memory hierarchy, cache design, microprocessor designs etc.

Introduction

Basic organization of computer and block level description of the functional units; Review of Digital Systems, Memory system design, FSM, Fixed and Floating-point data.

Computer Arithmetic and Design of ALU

Integer Data computation, Floating point arithmetic, Design of 8/16/32 bit ALU

CPU Architecture

Register Organization, Instruction formats, Instruction interpretation and Sequencing, RTL, addressing modes, instruction set. Case study - instruction sets of MIPS processor and ARM.

Assembly language programming

ARM instruction set, Introduction to Memory and Memory parameters. Classifications of memories, Allocation policies, Memory hierarchy and interleaving

Cache memory

Concept, architecture, mapping techniques. Virtual Memory, Page replacement policies. Data Path and Control Unit design, Memory, bus structure, hardwired and microprogrammed design approaches, Case study - design of a simple CPU

I/O Organization and Peripherals

I/O subsystems, DMA, privileged and non-privileged instructions, software interrupts & exceptions. Assessing and Enhancing Performance of Computer Systems; Pipelining, hazards, Flynn's classifications, Architectures - Multi-core systems, GPU

Text Book

- David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface Morgan Kaufmann ARM Edition, 2010.

Reference Book

- C. Hamachar, Z.Vranesic and Safwat Zaky, Computer Organization, McGraw Hill
- William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education
- John P. Hayes, Computer Architecture and Organization, McGraw Hill
- Morris Mano, Computer System Architecture, Pearson Education

Data Structures and Algorithms (IT1003)

Objective: To make student learn the linear and non-linear structures in which data can be stored and their pros and cons & to write algorithms using different data structures.

Course Outcome

- Understanding of data structures, linked-lists, trees, binary search trees, AVL trees, stacks, queues, priority queues, and hash-tables and graphs, ADT
- To apply & implement learned algorithm design techniques and data structures to solve problems.

Introduction, Arrays and Linked Lists
Basic Terminology, Elementary Data Organization, Asymptotic notations Efficiency of an Algorithm, Time and Space Complexity and trade-off**,** Single and Multidimensional Arrays, Sparse Matrices, Single, Double and Circularly Linked List, Header node based Linked List, Operations on a Linked List. Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List

Abstract Data Types (ADT), Searching and Sorting, **Priority Queues**
Stacks: Primitive Stack operations (Push & Pop) Implementation and Application of stack, Queue Implementation and Applications, Doubly Ended Queue, Sequential search, Binary Search, Comparison Sorting Techniques, Efficient Sorting Techniques, linear sorting techniques, Queue Definition & Implementation.

Hashing, Trees & Graphs- Hash table, hash function, collison & resolution strategies, Linear and Quadratic Probing, Trees, Binary Tree Representation, Expression Tree, Binary Tree Traversals, Binary Search Trees, Sequential & linked Representations of Graphs, Adjacency Matrix, Adjacency List, Graph Traversals, Connected Components, Minimum Cost Spanning Trees, Prims & Kruskal algorithm, Dijkstra algorithm

Text Books

- E. Horowitz, S. Sahni, S. Anderson-Freed “Fundamentals of Data Structures in C”, Second Edition, 2008, Universities Press.
- R. Kruse et al. , *Data Structures and Program Design in C,* Pearson Education
- S. Lipschutz , *Data Structures, Schaum's Outlines Series,* Tata McGraw-Hill.
- Mark Allen Weiss, “Data Structures and Algorithm Analysis in C (DSAC)”, Second Edition, 2002, Pearson Education India.

Reference Books

- “Algorithms Design”, Jon Kleinberg and Eva Tardos, First Edition, 2013, Pearson.
- “The C Programming Language”, Brian W. Kernighan and Dennis M. Ritchie, Second Edition, 2015, Pearson Education India.
- “Introduction to Algorithms”, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, Third Edition, 2009, MIT Press.

Web Development (IT1004)

Objective: To make students aware about the latest technologies in Web development and to give hands-on exposure on web development technologies.

Course Outcome

Students will be able to:

1. learn about the latest technologies in web development and get hands-on exposure on web development technologies.
2. to use the web application frameworks in web development and to deploy the modern web development tools and techniques.

Introduction to Web Development

Overview of web technologies, Web development tools and environments, HTML (Hypertext Markup Language), Working with text, links, images, and tables, Semantic HTML and accessibility, HTML forms and input validation, multi-page websites.

CSS (Cascading Style Sheets) & JavaScript

CSS and its role in web design, CSS selectors, properties, and values, Layout and positioning of HTML elements, Responsive design and media queries, JavaScript syntax, variables, and data types, Control structures, DOM manipulation and event handling, JavaScript frameworks/libraries, Backend Development, server-side programming & language, Handling HTTP requests/responses, Working with databases

Web Application Frameworks, Security and Deployment

Web application framework, frontend frameworks, State management and data binding, web vulnerabilities, Best practices for secure web development, User authentication and authorization, Optimization, Techniques for improving website performance, Web Deployment and Hosting, Setting up a web server, Deploying web applications.

Text Books

- Jon Duckett “HTML and CSS: Design and Build Websites”, First Edition, 2011, John Wiley & Sons
- Jon Duckett “JavaScript and jQuery”, First Edition, 2014, Wiley.

Reference Books

- “The Web Developer Bootcamp", by Colt Steele
- “Modern JavaScript from The Beginning 2.0 - 2023 Revamp
- The Complete Web Developer Course 3.0
- Web Design for Everybody: Basics of Web Development & Coding by University of Michigan

Discrete Mathematical Structures (IT1005)

Objective: To make student learn the fundamental mathematical concepts and terminology for discrete mathematics and structures.

Course Outcome

Students will be able to

- Understand logic and proof techniques
- Apply the above techniques in counting and solving recurrence relations
- Analyze real-world models using graph theory
- Extend their usefulness in succeeding courses in algorithm design and analysis, computing theory, software engineering, and computer systems

Methods of Proof, Logic & Proofs

Proof by contradiction, Proof by induction-weak and strong induction, Structural induction, Proof by proving the contrapositive, Proof by cases, and Proof by counter-example. Logic. Propositional Logic, Truth tables, Deduction, Resolution, Predicates and Quantifiers, Mathematical Proofs. Infinite sets, well-ordering. Countable and Uncountable sets, Cantor's diagonalization.

Sets and Sequences

Finite Sets, Power Set, Cardinality of finite sets, Cartesian Product, Properties of Sets, Vector Implementations of Sets.

Counting & Combinatorics

Counting, Sum and product rule, Principle of Inclusion Exclusion. Pigeon Hole Principle, Counting by Bijections. Double Counting. Linear Recurrence relations - methods of solutions. Generating Functions. Permutations and counting.

Relations, Graphs & Algebraic Structures

Relations, Equivalence Relations. Functions, Bijections. Binary relations, Posets and Lattices, Hasse Diagrams, Boolean Algebra, and Graphs and Trees. Structured sets with respect to binary operations. Groups, Semigroups, Monoids. Rings, and Fields.

Text Books

- Discrete Mathematics and its Applications, Kenneth H. Rosen, 7th Edition -Tata McGraw Hill Publishers, 2011.
- Mathematics for Computer Science, Eric Lehman; F Thomson Leighton; Albert R Meyer, 2010.

Reference Books

- Logic in Computer Science, Huth and Ryan, Cambridge University Press, 2014.

Principles of Data Communication (EC1006)

Objectives: To make student learn the fundamental concepts of signals and systems, communication technologies and information theory.

Course Outcomes

Students will be able to

- Understand fundamental concepts of signals and systems, various transforms, communication technologies and information theory.
- Understand the importance of coding, error detection and correction.

Signals and Transformations

Fourier Transform, LTI Systems, Convolution and LTI System Properties, Sampling theorem, Quantization, Pulse Code Modulation.

Information and Entropy

Entropy, Joint Entropy and Conditional Entropy, Relative Entropy and Mutual Information, Relationship Between Entropy and Mutual Information, Chain Rules for Entropy, Relative Entropy, and Mutual Information, Channel Capacity

Coding, Error Control Coding & Transmission Media

Source Coding- Prefix codes, Huffman Coding, Lempel Ziv Source coding, Parity Check Codes, Cyclic Redundancy Checks, Wired- Magnetic Media, Twisted Pairs, Coaxial Cable, Optical Fiber.

Wireless, Digital Modulation & Multiplexing

Electromagnetic Spectrum, Radio Transmission, Microwave Transmission, Infrared Transmission, Light Transmission, Modulation and Demodulation of Digital modulation schemes-ASK, FSK, PSK, DPSK, QPSK. Constellation diagram, M-ary Digital carrier Modulation, Frequency Division Multiplexing, Wavelength Division Multiplexing, Time Division Multiplexing, Code Division Multiplexing, Orthogonal Frequency Division Multiplexing, Space Division Multiplexing

Text Book

- V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and Systems”, 2nd Edition
- William Sinnema and Tom McGavern, “Digital, Analogue and Data Communication”, Prentice Hall.
- Proakis, John, and Masoud Salehi. Communication Systems Engineering. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2001. ISBN: 9780130617934

Reference Book

- B. P. Lathi et. al., Modern Digital and Analog Communication Systems, Fourth Edition, Oxford Publication.
- Haykin, Simon. Communication Systems. 5th ed. New York, NY: Wiley, 2009.

Principles of Management (MS1006)

Objective: This course is designed to be an overview of the major functions of management. It explores how organizations develop and maintain competitive advantage within a changing business environment. Upon completion, students should be able to work as contributing members of a team utilizing these functions of management.

Course Outcome

Students will be able to

- Understand how organizations adapt to an uncertain environment and identify techniques managers use to influence and control the internal environment.
- Practice the process of management's four functions: planning, organizing, leading, and controlling.

Nature and Functions of Management

Importance and Process of Management, Development of Management Thoughts, Managerial Roles.

International Business and its Environment

Globalization & WTO, Dynamics of development Global business environment, Internal Tech. of Forecasting.

Need for Organization

Principles and Process of Organizing, Authority, Delegation and Decentralization

Staffing and Directing

Requirement of Effective Direction

Text Book

- Koontz, Weihrich, Aryasri. Principles of Management, TATA McGraw Hill, New Delhi, 2004.

References

- P. C. Tripathi, P. N. Reddy, Principles of Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Prasad LM, Principles and Practice of Management, Sultan Chand & Sons, New Delhi.
- Samuel C. Certo, S. TrevisCerto, Modern management 10 Ed, PHI Learning, New Delhi, 2008
- James A. Stoner, Edward Freeman, Daniel Gilbert, Management, PHI Learning, New Delhi, 2007
- Williams/ Kulshrestha, Principles of Management, Cengage Learning, New Delhi, 2011

Environmental Studies (MS1007)

Objective: To make student learn the importance of environmental studies, different resources, ecosystem etc.

Course Outcome

Students will be able to

- Understand the Multidisciplinary nature of environmental studies.
- Structure and function of an ecosystem
- Environmental Pollution etc.

Nature of Environmental studies, Ecosystems

Definition, Scope and importance, Need for public awareness. Different resources, Concept of an ecosystem, Structure and its function, Food chains, Different eco systems, Biodiversity, Threats, In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution & Field Work

Causes, effects and control measures of different pollution, Nuclear hazards, Pollution case studies, Disaster management, Water conservation, rain water harvesting, watershed management, Case studies on Environmental ethics, Climate change, global warming, Case studies. - Wasteland reclamation, Environment Protection Act, Water Act, Wildlife Protection Act, Visit to a local polluted site and Study of ecosystems.

References:

- Agarwal, K.C.2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt.Ltd. , Ahmedabad — 380 013, India, Email: mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc.480p
- Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
- Cunningham, W.P.Cooper, T.H.Gorhani, E &Hepworth, M.T.2001. Environmental Encyclopedia, Jaico Publ. House. Mumbai, 1196p
- Dc A.K., Environmental Chemistry, Wiley Eastern Ltd.
- Down to Earth, Centre for Science and Environment(R)
- Gleick, 11.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press. 473

Physical Education (Sports) (MS1008)

Objective: To aware the students on the importance of physical education for a healthy life and train them on various sports, games, yoga, etc. for physical fitness.

Course Outcome

Students will be able to

- Understand the knowledge of various ways for maintaining both physical and mental wellness

Know your body

First Aid for basic medical conditions, CPR for emergency, Diabetic and Obesity condition of Indian and world, Importance of physical education.

Yoga and Meditation

Yoga for wellness and concentration, Meditation for wellness

Athletics and Aquatics

Rules, benefits and mastering of various track and field events such as Sprint, Marathon, Hurdles, Long Jump, High Jump, Javelin throw, Shot Put, Discus throw, etc.

Rules, benefits and mastering of various styles of swimming, butterfly, freestyle, backstroke, and breaststroke, Sports for physical fitness like Cricket, basketball, football, volleyball, etc.

References:

- Dr. V K Sharma, “Health and Physical Education”. New Sarasvati House Publishers.
- “Yoga: A Healthy Way of Living”. By National Council of Educational Research and Training.
- Mark Young. “The Complete Beginners Guide to Swimming”.
- Dr. Ashwini Bhardwaj. “A Complete Guide to Family Safety and First Aid”. GoodWill’s Publishers.

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Probability and Statistics (AS2001)

Objective: This course provides an elementary introduction to probability and statistics with applications. The topics covered in this course are basic concept of probability and statistics, random variables, probability distributions, Bayesian inference, joint probability distributions, random vectors, central limit theorem, confidence intervals.

Course Outcome
Students will be able to:

- Understand the basic concepts of probability and random variables.
- Apply the standard discrete and continuous probability distributions to real problems and use the inequalities.
- Extend the concept of random variables to higher dimensions and approximate probabilities by central limit theorem.
- Analyze the data by using statistical techniques of point and interval estimation and testing of hypotheses.

Probability: Axiomatic definition, Properties, Conditional probability, Bayes rule and independence of events, Random Variables, Distribution function

Probability Distributions: Discrete and Continuous random variables, Expectation, Function of random variable, Moments, Moment generating function, Chebyshev's and Morkov's inequality. Bernoulli, Binomial, Geometric, Negative binomial, Hypergeometric, Poisson, Discrete uniform, Continuous uniform, Exponential, Gamma, Normal.

Random vector: Joint distributions, Marginal and conditional distributions, Moments, Independence of random variables, Covariance, Correlation, Levy's Central limit theorem (independently and identically distributed with finite variance case), Normal approximation to Binomial and Poisson

Statistics: Introduction: Population, Sample, Parameters, Point Estimation: Method of moments, Maximum likelihood estimation, Unbiasedness, Consistency, Interval Estimation: Confidence interval, Tests of Hypotheses, Linear Regression.

Text/Reference Books

- Sheldon M. Ross, An Introduction to Probability Models, 10th Edition, Academic Press, Elsevier.
- Sheldon M. Ross, An Introduction to Probability and Statistics for Engineers and Scientists, 3rd Edition, Academic Press, Elsevier.
- Rohatgi, V. K. and Saleh, A. K. (2000), An Introduction to Probability and Statistics, 2nd Edition, Wiley-interscience.
- Bertsekas, D. P. and Tsitsiklis, J. N. (2008), Introduction to Probability, Athena Scientific, Massachusetts.

Object Oriented Methodologies (IT2001)

Objective: To learn the concept of Object Orientation and its applicability in modeling real life scenarios and to get acquainted with UML Diagrams and Object Oriented Analysis Processes, and concepts like data abstraction, encapsulation, inheritance etc.

Course Outcomes

Students will be able to

1. Understand and apply the object-oriented approach in software development.
2. Optimize the codes by applying the concepts of modularity, reusability etc.
3. Design Java programs to model real-world systems and analyze their behavior using object-oriented principles and create models for software design using Unified Modeling Language (UML).
4. Apply Design principles for a flexible, maintainable software design

Introduction

Characteristic differences between Procedural and Object Oriented approach for programming, Concepts of Class, Objects, and Object Oriented Characteristics. Building upon basic programming skills in OO, specifically using basic Java programming constructs for object-oriented problem solving (e.g., Classes: Abstraction, inheritance, interfaces, polymorphism), Methods in OO Programming: Method overloading and overriding.

Models

Design and analysis of larger, more complex programs using Object Oriented Modeling with UML. Need for models, Static and Dynamic modeling diagrams, and role of Use Case Diagrams. Role of Object orientation in problem solving, Java program to model a real world system, and subsequently analyze its behavior. Java implementation for GUI, Event handling and Applets for Web enabled applications. Developing Applications with GUI and Database connectivity.

UML

Overview of UML, Class Diagrams Object Diagrams. Sequence Diagrams, Collaboration Diagrams, Static Diagrams: Working with Diagrams and role of Modeling, Making Effective use of UML, Communicating with Others, Back end documentation What to keep, and What to throw away, Iterative Refinement Behavior, Iterative Refinement Minimalism, Object Oriented design Principles & Intro to Design Patterns.

Text Books:

- H. Schildt, Java 2: A Complete Reference 4th ed, McGraw-Hill, 2001
- G. Booch, Object-Oriented Analysis and Design with Applications 2nd Edition, PHI, New Delhi, 1993

Theory of Computation (IT2002)

Objective: This course is about the machine construction logic.

Course Outcomes
Students will be able to:

- understand automata as an abstract model of computation and its significance
- relate the concepts of automata, grammar and languages and their applications
- understand the (Chomsky) hierarchy and argue about model limitations
- identify the characteristics for which no computational solution exists.

Regular languages
Notion of a formal language, DFAs and notion for their acceptance, informal and formal definitions. Class of regular languages, Closure of the class under complementation, union and intersection. Strategy for designing DFAs, Pumping lemma for regular languages, NFAs. Notion of trees, Construction of equivalent DFAs of NFAs. NFAs with epsilon transitions, Closure properties for languages, States minimization of DFAs,

Context free languages
Notion of grammars and languages generated by grammars. Equivalence of regular grammars and finite automata. Context free grammars and their parse trees. Context free languages. Ambiguity, Elimination of useless symbols, epsilon productions, unit productions from CFGs. Chomsky normal form, Pumping lemma, Closure properties of CFLs, Decision problems for CFLs.

Pushdown automata (PDAs)
Deterministic and nondeterministic. Instantaneous descriptions of PDAs. Language acceptance by final states and by empty stack. Equivalence of PDAs and CFGs,

Turing machines
Recursively enumerable languages, Turing machines (TMs)-their instantaneous descriptions. Language acceptance by TMs, Types of TMs, Church-Turing hypothesis and its foundational implications, Codes for TMs. Recursively enumerable (r.e.) and recursive languages. Existence of non-r.e. languages. Notion of undecidable problems. Universal language and universal TM. Separation of recursive and r.e. classes.

Textbooks:

- J. E. Hopcroft , R. Motwani , J. D. Ullman “Introduction to Automata Theory, Languages, and Computation”, , Pearson Publications, Third edition.
- “An Introduction to Formal Languages and Automata”, Peter Linz, Narosa Publications, Fourth edition.

References:

- Michael Sipser, “Introduction to the theory of Computation”, Cengage Learning, Third edition.
- N.Chandrasekaran, “Theory of Computer Science Automata, Languages and Computation”, K.L.P. Mishra, PHI, Third Edition.

Operating Systems (IT2003)

Objective: To make student learn the design and services provided by an operating system particularly xv6 operating system.

Course Outcome
Students will be able to:

- Understand operating systems
- Memory management, input-output and storage management
- concept of distributed systems, OS Systems security etc.

Introduction, System Calls & Process and Thread Management
OS Basics, Definition, Operating Systems as resource manager, Evolution of OS, Structural overview, Types of System Call, Hardware requirements, Process Model, Process States, Operation on Process, System calls for process operations, Overview of Threads, Multithreading Models, Threads and their Management; POSIX Threads, Implementing Threads in User space and Kernel space

CPU Scheduling, Interprocess Comm., Process Synchronization & Deadlocks
Scheduling Criteria & Algorithms, Multiple-Processor Scheduling, Concept of shared memory, message passing, pipes, The Critical-Section Problem, Peterson's Solution, Synchronization, Semaphores, Problems of Synchronization, Dynamic Resource Allocation, Deadlock Characterization, Prevention, Avoidance, Detection, Recovery

Memory Management, Input Output and Storage Management, File Management
Main Memory Basics, Swapping, Contiguous Memory Allocation, Paging, Structure Segmentation, Virtual Memory, Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Principles of I/O hardware, I/O Software Layers, Mass-Storage Structure, Disk Scheduling & Management, File Concept, Protection, Mounting, Sharing, Structure, Implementation, Directory Implementation, Allocation Methods

Advanced Topics
Multiprocessor Hardware and OS, scheduling and synchronization, multicomputer hardware, distributed shared memory, remote procedure call, concept of distributed systems; OS Systems security, controlling access to resources, exploiting software

Text Book

- R H. Arpaci-Dusseau and A C. Arpaci-Dusseau “Operating Systems: Three Easy Pieces”, Arpaci-Dusseau Books, November, 2023 (Version 1.10)

Reference Book

- P. B. Galvin and G Gagne “Operating System Concepts”, Abraham Silberschatz, 8th Edition, 2008, Wiley.
- A S. Tanenbaum and H Bros “Modern Operating Systems” 4th Edition, 2015,
- W Stallings “Operating Systems: Internals and Design Principles”, Prentice Hall

Software Engineering (IT2004)

Objective: To apply software engineering theory, principles, tools and processes, as well as the theory and principles of computer science and mathematics, to the development and maintenance of complex, scalable software systems

Course Outcome

Students will be able to:

- Understand and apply software lifecycle development models to effectively manage the software development process and
- utilize software design principles and modeling to develop scalable and maintainable software systems.
- Develop and implement project plans, apply metrics for measurement, estimate costs etc in software project development to ensure quality.

Introduction to Software Engineering

Software characteristics, Software components, Software applications, Software Engineering Principles, Software metrics and measurement, monitoring and control. Software development life-cycle, various model and recent developments in models.

Requirements

Elicitation Techniques, Requirements analysis, Modeling and Architecture, Functional versus object-oriented approach of design, design specification, Cohesiveness and Coupling. Overview of SA/SD Methodology, structured analysis, UML diagrams. Data flow diagrams (DFDs), extending DFD to structure chart.

Software project Planning

Project scheduling. Software Metrics: Size Metrics, Cost estimation using models like COCOMO. Risk management, Software Reliability and Quality Assurance: Reliability issues, Reliability metrics, reliability models, Software quality, ISO 9000 certification for software industry, SEI capability maturity model, Client server software development.

Verification and validation

Code inspection, test plan, test case specification. Level of testing, Various testing Top down and bottom-up integration, Alpha and Beta, System and debugging, functional structural testing, Software testing strategies, Software reliability and quality, Software maintenance and reuse, Structured Vs unstructured maintenance, Maintenance Models, Configuration Management, Reverse Engineering, Software Re-engineering.

Text Books

- Sommerville “Software Engineering”, Tenth ed, 2016, Pearson Education .
- R S. Pressman & B R. Maxim “Software Engineering: A practitioner’s approach”, Eighth Edition, 2014, Mcgraw-Hill.

Reference Book

- W. S. Jawadekar “Software Engineering: Principles and Practice”, 2004, Tata McGraw-Hill Education.

Principle of Economics (MS2001)

Objective: This course introduces economic analysis of individual, business, and industry choices in the market economy. Topics include the price mechanism, supply and demand, optimizing economic behavior, costs and revenue, market structures, factor markets, income distribution, market failure, and government intervention. Upon completion, students should be able to identify and evaluate consumer and business alternatives in order to achieve economic objectives efficiently.

Course Outcome

Students will be able to:

- Understand that economics is about the allocation of scarce resources, that scarcity for ceschoice, tradeoffs exist and that every choice has an opportunity cost.
- List the determinants of the demand and supply for a good in a competitive market and explain how that demand and supply together determine equilibrium price.
- Understand the role of prices in allocating scarce resources in market economies and explain the consequences of price controls.
- Define an externality and a public good and why explain the presence of externalities and public goods make markets inefficient. Analyse various government policies aimed at solving these inefficiencies.

Introduction to Economics

Production Possibilities, Supply and demand, analysis; The price system and the mixed economy

Elasticity; Consumer choice and the theory of demand

The profit-maximizing competitive firm and market supply; Long-run supply in competitive markets, Production and cost

Types of Market:

Monopoly; Perfect Markets; Monopolistic competition and oligopoly; Antitrust policy and regulation of markets

Introduction to macro Economics

Macro-Economic Equilibrium GDP; Unemployment; Inflation

Text Books

- Principles of Economics: Gregory Mankiw
- Economics: Samuelson

Introduction to Finance (MS2002)

Objective of the Course: This course is a rigorous introduction to the study of the basic principles of finance and their application to the usual financial issues and decision-making of business enterprises. The main objective of this course is for the student to obtain at least a good working-knowledge of the topics stated in the tentative course outline below for use in future courses and for careers.

Course Outcome
Students will be able to:

- Identify the objective of the firm and the role of managerial finance.
- Outline the implications of the separation of ownership and control.
- Evaluate financial statements using ratio analysis.
- Explain the general concept of valuing financial assets.
- Explain the characteristics of debt and equity securities.
- Identify why firms need to invest in working capital Outline the alternative sources of long-terms fund.

Introduction to financial Management
Financial statement basics, Ratio Analysis

Time value of Money
Capital Budgeting, Relationship between risk and return

Long term financial decisions
Working Capital Management, Dividend Decision

Introduction to Financial Systems
Capital Markets, Introduction to International finance and risk Management

Text Books ·

- Ross, Westerfield, Jordan, Essentials of Corporate Finance
- James C. Van Horne and John M Wachowicz, Fundamentals of financial management.
- Jonathan Berk, Financial Management

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Design and Analysis of Algorithms (IT2005)

Objective: To analyze the asymptotic performance of algorithms, Write rigorous correctness proofs for algorithms and to demonstrate a familiarity with major algorithms and data structures.

Course Outcome

Students will be able to:

- Demonstrate the ability to fully understand the analysis of various known algorithms.
- Identify problems where algorithm design paradigms can possibly be applied.
- Explain graph algorithms and their analysis and to understand the notions of computational intractability and learn how to cope with hardness
- Synthesize efficient algorithms in common engineering design situations.

Introduction

Basic concepts, Growth of Functions – Asymptotic Notations, Tradeoff between Time and Space Complexities, Searching and Sorting - Sorting in Linear Time

Divide and Conquer & Randomized Algorithms

Definition, Designing, Analysis, Proof of Correctness, Recurrence Relations, Master's Theorem, Definition, Designing, Analysis, Proof of Correctness

Dynamic Programming & Greedy Algorithms

Definition, Designing, Analysis, Proof of Correctness, Longest common subsequence, Optimal Binary Search Trees, Matrix Chain Multiplication, Definition, Designing, Analysis, Proof of Correctness, Interval scheduling, Huffman tree, Knapsack problems

Graph Algorithms & Complexity classes

Traversal, Topological sort, Minimum Spanning Tree, Single Source Shortest Path, All Pairs Shortest Path, Maximum Flow, P, NP, NP-Complete, NP-Hard

Approximation Algorithms

Definition, Designing, Analysis, Proof of Correctness, Vertex cover problem, Travelling Salesman problem, Subset Sum Problem,

Text Books

- T H Cormen, C E Leiserson, R L Rivest, and C Stein E, Introduction to Algorithms, MIT Press, 4th edition, 2022.

Reference Books

- J Kleinberg, and E Tardos, Algorithm Design, Pearson, 1st edition, 2013

Principles of Programming Languages (IT2006)

Objective: This course describes the fundamental concepts of programming languages by discussing the design issues of the various language constructs, examining the design choices for these constructs in some of the most common languages, and critically comparing design alternatives.

Course Outcomes
Students will be able to:

- Understand the design choices of various constructs of programming languages and their implementation details.
- Understand the significance of implementation, and make better use of languages that are already known.
- Develop the ability to quickly learn new languages
- Assess various programming languages and choose an appropriate language for the task at hand.

Introduction, Syntax and Semantics
Rationale for studying programming languages, criteria used for evaluating programming languages and language constructs, context free grammar, BNF, attribute grammars, semantics: operational, denotational, and axiomatic semantics, various phases of compilers

Design Issues for statements and subprograms
Design issues for expressions and assignment statements, control statements, subprograms and their implementation

Introduction to Concurrency and Logic Programming languages
Motivation for concurrency, semaphores, Monitors. Introduction to predicate calculus, logic programming using Prolog, Inferencing process in Prolog, Applications and Limitations of Prolog.

Introduction to Functional Programming
Functional programming with Lisp and Scheme, brief introduction to ML, Haskell, and F#, Comparison of functional and imperative languages.

Textbooks:

- R W. Sebesta "Concepts of Programming Languages", , Tenth Edition, Pearson

References:

- Allen B Tucker and Robert E. Noonan, "Programming Languages: Principles and Paradigms", , second edition, Mc Graw Hill
- Carlo Ghezzi and Mehdi Jazayeri "Programming Language Concepts", , Third edition, Wiley

Computer Networks (IT2007)

Objective: To grasp the fundamental concepts of computer networking, including the OSI model, TCP/IP protocol suite, network topologies, and addressing schemes and to learn about various networking protocols and technologies.

Course outcomes
Students will be able to:

- Explain the fundamental concepts of computer networking, including the OSI model, TCP/IP protocol suite, network topologies, and addressing schemes.
- Apply various networking protocols and technologies, such as Ethernet, TCP, IP, UDP, HTTP, DNS, DHCP, etc.
- Use network management principles & to Assess network problems systematically and implement effective solutions.
- Use emerging networking technologies such as SDN, NFV, and IoT

Introduction to Computer Networks
Evolution of computer networks, networks topologies. Layering and protocols.

Physical Layer & Data link layer: Different types of transmission media, errors in transmission: attenuation, noise. Repeaters. Encoding (NRZ, NRZI, Manchester, etc. Error detection, Sliding Window, Stop and Wait protocols, Framing, HDLC, PPP, Channel Access Protocols, Token Ring, Wireless LAN, Virtual circuit switching.

Network Layer & Transport Layer: Internet addressing, Internet Protocol (IPv4, IPv6), ARP, ICMP, DHCP, Internet QoS, routing algorithms (RIP, OSPF, BGP), Software Defined Networking, UDP, TCP, Connection establishment and termination, Sliding window revisited, Buffer Management and Congestion Control at the Transport Layer, Timers, Retransmission.

Session, Presentation, and Application Layers: DNS, SMTP, IMAP, HTTP, etc.

Text Books:

- S. Tanenbaum, Computer Networks, 4th Ed, Pearson India, 2003.
- L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 4th Ed, Elsevier India, 2007.

Reference Books:

- J. F. Kurose and K. W. Ross, Computer Networking: A Top Down Approach, 3rd Ed, Pearson India, 2005.
- D. E. Comer, Internetworking with TCP/IP Vol. 1, 5th Ed, Prentice Hall of India, 2006.
- B. Forouzan, Data Communications and Networking, 5th Ed, Tata Mcgraw Hill, 2013.

Computer Graphics and Visualization (IT2008)

Objective: To prepare students in computer graphics, visualization, and related areas and to develop a complete graphics implementation in which the students implement every aspect of the graphics pipeline. This involves a substantial software project in C/C++ , Python, OpenGL, and WebGL libraries.

Course outcomes
Students will be able to:

- Understand computer graphics, visualization, and related areas
- Develop a complete graphics implementation and
- Prepare software project in C/C++ , Python, OpenGL, and WebGL libraries

Introduction
Basics, applications and scope, Graphics standards, Interaction (sample- and event-driven) and GUI features. Display Systems, Graphics pipeline, Line-Drawing Algorithms, Frame Buffer, Circle-Generating Algorithms, Ellipse-Generating Algorithms. Fill Algorithm, Line Attributes, Line Type, Line Width, Digital signal processing, Sampling, aliasing and Antialiasing, Super-sampling Straight Line Segments, Pixel-Weighting Masks, Area Sampling Straight Line, Segments, Filtering Techniques, Pixel Phasing, Compensating for Line intensity Differences, Antialiasing, Clipping algorithms.

Transformations
Affine Rotation, Translation, Scale, Reflection and Shear; Viewing, Solid Modelling: Wire-frame, Octrees, Sweep, Boundary representations. Regularized Boolean set operations, Constructive Solid Geometry (CSG); Hierarchical Scene and Object graphs, Scene Description. Hidden Surface Removal: Back face detection, Z-buffer method, Painter's algorithm, scan-line algorithm, BSP-trees, Area subdivision method, Ray tracing.

Hidden Surface Removal
Back face detection, Z-buffer method, Painter's algorithm, scan-line algorithm, BSP-trees, Area sub-division method, Ray tracing. Shading & Illumination Reflection Models, Ambient Light, Diffuse Reflection, Specular Reflection and the Phong Model. Combined Diffuse and Specular Reflections, Colour Considerations, Transparency, Shadows, Texture mapping, Polygon-Rendering Methods, Interpolation and Approximation Splines, Continuity, Natural Cubic Splines, Hermite Interpolation, Cardinal Splines, Kochanek-Bartels Splines, Bezier Curves and Surfaces, Bezier, Curves, Matrix Representation, Conversion. Fractals, Generation and Classification, Self-Similar Fractals, Affine Fractal-Construction Methods. Applications. Introduction to GPUs.

Text Books

- Donald Hearn & M. Pauline Baker, Computer Graphics.

Reference Books

- Foley, van Dam, Feiner & Hughes, Computer Graphics Principles & Practice

Database Management System (IT2009)

Objective of the course: The main objective of this course is to provide students with the background to design, implement, and use database management systems.

Course Outcomes
Students will be able to:

- Apply knowledge of database techniques to develop relational models and identify and define the information needs and requirements appropriate to its' business context and solution.
- Use current relational database techniques, skills, and tools necessary for developing information systems.
- Develop the ability to explore recent advances like NoSQL and Linked data principles etc. along with applications towards data warehousing & data mining.

Database Systems
Introduction of Data Base systems, User Categories and Architecture, Data Abstraction and Independence. Data Modeling, Mapping Cardinalities, Generalization, Specialization and Aggregation, Case Study ER Diagrams.

Basic of SQL, **SQL & PL/SQL**
Overview of Query Language, SQL, Queries, Relational Model, Concepts of Keys, Weak Entity, Surrogate Keys, CODD Rules, Anomalies in Relational Model, Mapping from ER Model to Relational Model, Data Manipulation Language and DDL Operations, Set Operations, Aggregate Functions, Nested Subqueries, Modification of the Database, PL/SQL, Data Types, Program structure, Embedding SQL statements, Using conditional statements and loops, Functions and Procedures, Cursor, Triggers.

Relational Algebra & Transactions and Concurrency Control
Basic & Extended Operators, Joins, nested query in DBMS, Tuple Relational Calculus, Relational Database, Functional Dependencies, Attribute Closure, Canonical Cover, Decomposition, ACID Properties, Transaction Atomicity, Durability, Isolation, Serializability, Schedule, Isolation Levels. Lock-Based Protocols, Deadlock Handling, Multiple Granularity, Timestamp based Protocols, Index Locking, Recovery.

Query Processing
Overview, Measuring Query Cost, Selection Operation, Sorting, Join Operation, Query Optimization, Transformation of Relational Expressions, etc. Storage and File structure

Text Books

- Silberschatz, Korth and Sudarshan, Database System Concepts, McGraw-Hill.

Reference Books

- R Ramakrishnan, and J Gehrke, Database Management Systems McGraw-Hill.
- R E, Shamkant B. Navathe, Addison-Wesley, Fundamentals of Database Systems (6th ed.)

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Cyber Security (IT 3001)

Objective: The course is outlined with the objective to inculcate necessary skill, education and abilities among the students in the sphere of cyber security

Course Outcome:
Student will be able to:

- Model attack vectors & defense control in confidentiality, integrity and availability.
- Implement Symmetric & Asymmetric cryptographic algorithms & Test the security of the web application, Vulnerability Assessment and Penetration Testing.
- Design and Secure the Network Infrastructure by implementing IDS, Firewalls and Analysis of Malware to find out Indicator of Compromise.

Introduction and basic terminology
Cyber Security and CIA Triad, basic cyber threats to CIA, cyber-attack surfaces, recent cyber-security incidents and their high-level analysis

Basic Cryptography & Authentication, Authorization and Privilege
Role in confidentiality for data at rest, motion, process. Symmetric and Asymmetric Cryptography, Hashing and Digital Signature and some example, understanding digital signature, Digital Certificate and PKI., role of PRNG, strong Authentication, distinction between authorization and authorization, access control, Mandatory and Discretionary Access control, role based authorization, privilege and privilege escalation.

Application Security
Method of Reconnaissance, Port Scanning and Enumaration. Stages of Vulenaribility Assessment. Owasp Model. Basic application vulnerabilities, Basic mitigations of buffer overflow, Web Client Security, DOM, Java Script Vulnerability, Cookies and Cookie attributes Secure, http only, session and session ID, hijacking, http vs. https and SSL/TLS and version issus, XSS, CSRF, SQL Injection, Command Injection concepts, Vulnerabilities in DNS, Routing and IP protocols & suggested remedies.

Perimeter protection & Network Security
Host Intrusion Detection techniques, Network Intrusion Detection, Snort, Firewall vs. Intrusion Detection tool, Firewall rules and customization techniques. Various malware classes and their characteristics, static & dynamic analysis, Signature vs. behavioral detection., WEP, evil twin attack, unauthorized access point based attacks.

Text Book

- J. Anderson "Security Engineering"Ross, Security Engineering, 3rd Ed. Wiley,
- William Stallings "Cryptography and Network Security" 7th Ed. Pearson,

References

- D Stuttard and M Pinto "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws" , 2nd Edition, ISBN: 978-1118026472.
- Peter Kim, The Hacker Playbook: Practical Guide To Penetration Testing (vol. 1 and 2) by. Third Edition, ISBN: 978-1980901754

Introduction to Machine Learning (IT3002)

Objective: This course gives an introduction to machine learning. It is about unified understanding of the models and algorithms used in machine learning.

Course Outcomes
Students will be able to:

- Understand Core Concepts of Machine Learning, comprehend the fundamentals of supervised, unsupervised, and reinforcement learning and their applications.
- Develop Predictive Models and implementation of different algorithms.
- Optimize Learning Models and apply optimization techniques.
- Analyze and Evaluate Models and to perform model evaluation
- Explore Dimensionality Reduction and Latent Models and to gain foundational knowledge of deep neural networks and reinforcement learning.

Course Logistics and Introduction to Machine Learning
Supervised learning, Decision Trees for Classification and Regression, Random Forest, Bagging, Boosting, Linear Regression, Learning via Probabilistic Modeling

Probabilistic Models for Supervised Learning
Discriminative and Generative Approaches, Basics of Convexity, Gradient Descent, Stochastic GD Hyperplane based Classifiers (Perceptron and SVM) SVM (Contd), Multiclass and One-Class SVM Making Linear Models Nonlinear via Kernel Methods

Intro to Unsupervised Learning
K-means Clustering and Extensions, Parameter Estimation in Latent Variable Models Expectation Maximization-GMM Model Selection, Evaluation Metrics, Learning from Imbalanced Data Linear and Non-Linear Dimensionality Reduction Bias/Variance Trade-off, Some Practical Issues, Semi-supervised and Active Learning

Introduction to Artificial Neural Networks
Introduction to Deep Neural Networks, Learning to Recommend via Matrix Factorization/Completion, Reinforcement Learning

Text Book:

- Duda, Peter Hart, David Stork, “Pattern Classification”, Wiley; Second edition
- Tom Mitchell, “Machine Learning”.
- Hal Daumé III, “A Course in Machine Learning (CIML)”, 2017 .

Reference Book:

- Christopher Bishop, “Pattern recognition and machine learning”, Springer, 2007.
- Kevin Murphy, “Machine learning: a probabilistic perspective”, MIT Press, 2012.
- E. Alpaydin, “Machine Learning”,(https://www.cmpe.boun.edu.tr/~ethem/i2ml3e/)
- Kevin Murphy, “Machine Learning: A Probabilistic Perspective (MLAPP)”, MIT Press, 2012

Image and Video Processing (IT3003)

Objective: To provide the visualization of relationships between spatial and frequency, understanding of signal processing techniques, provide an idea of multimedia data (image, video) and exposure to various image and video compression standards.

Course Outcomes
Students will be able to:

- Understand digital image formation and visualization and analyze.
- Evaluate the techniques for image enhancement and image restoration.
- Categorize various image and video compression standards and to apply the image and video processing algorithms to solve various real-time problems.
- Develop new state-of-the-art image and video processing methods.

Digital Image Fundamentals
Simple image model, digital image formation, sampling, quantization, resolutions and representation, relationship among pixels, types of digital images.

Color Image Processing & Image Enhancement
Color Representation, Chromaticity Diagram and Color Spaces, types of digital imaging and application areas, Point Processing: Contrast Stretching, Power-law and Gamma Transformation. Histogram Processing: Histogram Equalization and Matching

Filtering and Restoration
Degradation function and Noise Models, Spatial Domain Filtering, Smoothing Linear and Nonlinear Filters, Adaptive Filtering, Sharpening Linear and Nonlinear Filters, Unsharp Masking, High-boost Filtering. Frequency Domain Filtering, Homomorphic Filtering, Periodic Noise Reduction & Inverse Filtering & Wiener Filtering.

Edges, Lines, Boundary Detection & Morphological Operations and Application
First & second Order Edge Operators, Multi-scale Edge Detection, Canny Edge Detection, Hough Transform, Boundary, Skelton, Convex-Hull, Thinning, Pruning etc.

Segmentation & Feature Extraction & Compression: Model-based and probabilistic methods and Image Classification Optimal and Multilevel Thresholding, Gray Image Segmentation, Watershed Algorithm. Lossy and Lossless compression techniques, JPEG, JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video Streaming.

Text Books

- Willam K. Pratt, Digital Image Processing John Willey & Sons, 4th Ed. 2007
- Gonzalez, Rafael C., and R. E. Woods, Digital Image Processing Pearson Education, 4th edition, 2018

Reference Books:

- The Essential Guide to Video Processing by Alan C. Bovik, Academic Press, 2nd edition, 2009

Artificial Intelligence (IT3004)

Objective: To introduce the basic principles of Artificial Intelligence, problem solving, and knowledge representation

Course Outcomes

Students will be able to:

- Grasp the historical, ethical implications & basic principles of artificial intelligence
- Apply search algorithms, optimization methods, & game strategies to design intelligent problem-solving systems & decision-making and planning.
- Use probabilistic reasoning, Bayesian networks, and decision theory to address uncertainty in dynamic environments and
- Apply decision trees, ensemble methods, and reinforcement learning to learn from observations.

Introduction

Definition, History, The Turing Test, Machine Learning and Robotics, Expert Systems, Current status of AI, Weak AI, Strong AI, Ethics and Risks of Developing AI, Intelligent Agents, Agent programs, Different agents, Components, Agent Architectures

Problems Solving by Searching

Searching for Solutions, Uninformed Search Strategies, Iterative deepening, Bidirectional search, Search Strategies and Optimization, Genetic algorithms, CSP, Intelligent backtracking, minimax algorithm, Alpha-Beta Pruning, Real-Time Decisions

Knowledge Engineering

Knowledge-Based Agents, Propositional and first order logic, Knowledge Engineering, Inference, Unification and Lifting, Forward & Backward Chaining, Ontological Engineering, Planning, Planning Graphs, Logic; Acting in the Real World- Time, Schedules, and Resources, Hierarchical Task Network Planning, Conditional Planning

Uncertainty

Uncertainty, Axioms, Inference Using Full Joint Distributions; Probabilistic Reasoning, Bayesian Networks, Hidden Markov Models, Kalman Filters, Utility Theory, Decision Networks, Expert Systems, Making Complex Decisions, Inductive Learning, Learning Decision Trees, Ensemble, Statistical Learning Methods, Reinforcement Learning

Text Books

- P Norvig and S J. Russell, Artificial Intelligence: A Modern Approach, 4th ed. Pearson Education, 2022
- Deepak Khemani, First Course in Artificial Intelligence, 6th Ed., McGraw Hills,

Reference Books:

- K Knight, E Rich, S B. Nair, Artificial Intelligence, 3rd Ed., McGraw Hills, 2017
- J P Mueller, L Massaron, Artificial Intelligence For Dummies, 2nd Ed., O'Reilly,2021

Design Thinking and Innovation (IT 3501)

Objective: The objective of this course is to learn the innovation cycle of Design Thinking process for developing innovative products.

Course Outcome

Student will able to

- Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of the Design Thinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, and techniques during prototype development and to perceive individual differences and its impact on everyday decisions and further Create a better customer experience

An Insight to Learning, Remembering Memory & Emotions

Kolb's Learning Styles, Assessing and Interpreting, Understanding the Memory process, Problems in retention, Memory enhancement techniques, Understanding Emotions:

Basics of Design Thinking & Being Ingenious & Fixing Problem

Definition, Need, Objective, Concepts & Brainstorming, Stages of Design Thinking Process, Bottlenecks of Processes-Process Centric approach, Creative thinking process, Problem Solving, Testing Creative Problem Solving

Process of Product Design, Prototyping & Testing and Celebrating the Difference

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, User Interface Design, Mobile App Design, Prototype creation, Rapid Prototype Development process, Testing, Test Group Marketing, Group Discussion

Design Thinking & Customer Centricity & Feedback, Re-Design & Re-Create

Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Feedback loop, rapid prototyping & testing, final product, Creative Solution".

Text Book

Reference Book

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Data Analytics (IT3006)

Objective: The objective of this course is to make student learn about mining issues and methods/algorithms.

Course outcomes:
Students will be able to:

- Get exposure of data analysis steps
- Perform data preprocessing task
- Apply logic to implement different category of Algorithms

Introduction
Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Preprocessing the Data (Data Cleaning, Integration, Transformation & Reduction)

Mining Association Rules
Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, APRIORI, Variations of APRIORI (Sampling, Hash Based, Partitioning, Transaction Reduction), Frequent Pattern Growth, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules, Concept of LIFT, Clustering of Association rules.

Classification and Prediction
Classification by Decision Tree Induction, Bayesian Classification, Classification & Prediction continues, Classification by Back propagation, Classification Based on concepts from association Rule Mining, SVM, Regression Analysis, Classifier Accuracy.

Clustering
Data types in cluster analysis, Categories of clustering methods, partitioning methods- K-Means, PAM, CLARA, CLARANS, KNN. Hierarchical Clustering- Agglomerative and Divisive Clustering, BIRCH and Chameleon, Density Based methods-DBSCAN, CURE, OPTICS, Grid Based Methods- COBWEB

Text Book

- J. Han, M. Kamber, Jian Pei “Data Mining: Concepts and Techniques” 3rd Edition, 2011

References

- Hadzic F., Tan H. & Dillon T. S. “Mining data with Complex Structures,” Springer, 2011
- Yates, R. B. and Neto, B. R., “Modern Information Retrieval” Pearson Education, 2005

Biology for Engineers (AS1010)

Objective: The objective is to provide the fundamental knowledge of Modern Biology and its application.

Course Outcome

Students will be able to:

- Get basic understanding of the Advanced Biology
- Get exposure to different areas of Biology including Cell Biology, Microbiology, Molecular Biology, Biochemistry and Immunology.
- Learn the principles of different advanced laboratory techniques used in biological research works and interdisciplinary research.

Introduction

Introduction to living organisms, Different cell organelles and cellular processes. Prokaryotes and Eukaryotes cells.

Structures and functions

Structures and functions of bimolecules, DNA, RNA, Carbohydrates, Proteins and Lipids.

Immunity, Electrical signal & Biomaterials

Antigen, Antibody, Antigen-Antibody interactions, Electrical signal of cells, HH model. Concept of Stem cells, Differentiation, Characterization**,** Biomaterials for tissue engineering, 3D bio-printing, DNA origami and Biocomputing.

Text book

- Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Molecular Biology of the Cell.

References

- Prescott, Harley, and Klein's Microbiology by Joanne M. Willey, Linda Sherwood, and Christopher J. Woolverton.
- Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer.
- Immunology by Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby.

French Language (MS 1502)

Objective: To equip students with the necessary skills to understand, speak, read, and write French effectively, allowing them to communicate in everyday situations, including basic grammar, vocabulary, pronunciation, and cultural understanding, often aiming to reach a specific proficiency level.

Course outcome
At the end of this course, Students will

- be familiar with the pronunciation of French letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction
Personal Information, Introducing yourself (name, age, nationality), Family members Basic greetings and farewells

Basic Communication
Asking and answering simple questions, Expressing likes and dislikes, Making requests.

Numbers and Time
Counting, Telling time, Days of the week and months

Everyday Life
Describing daily routines, Talking about hobbies and interests, Weather descriptions

Places and Directions
Asking for and giving directions, Identifying basic places in a town

Shopping and Dining
Making simple purchases, Ordering food and drinks

Basic Grammar
Subject-verb agreement, Present tense verb conjugation, Basic sentence structure, Articles (le, la, les, un, une)

German Language (MS 1500)

Objective: The student will learn the basics of standard German language, and will get to know about the norms of language of German.

Course outcome
At the end of this course, Students will

- Be familiar with the pronunciation of German letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction
Alphabets, Numbers, Greetings

Phrases
Basic introductory phrases

Calenders
Days of the week, Months

Introduction of self and introduction of others
Map, Time, Vocabulary- things around, Nations and nationalities, stationery, professions, hobbies

Grammar
present tense, past tense, plurals, pronouns, verb conjugations, (regular, and three or four important irregular verbs), prepositions, and so on

Japanese Language (MS 1501)

Objective: The student will learn the basics of standard Japanease language, and will get to know about the norms of language of Japan.

Course outcome

At the end of this course, Students will

- Be familiar with the pronunciation of Japan letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Introduction to Japanese Syllables (phonetic alphabet), greetings & Self introduction, Identifying things, point objects and listen to their names, Listen to things and places etc. Creating shopping lists

Time Delay

Introduction to Time, day of the week, simple inquiries on telephone, Means of transport, Basic conversations of everyday life.

Frame questions in Japanese

Vocabulary of giving and receiving objects. Stating impressions/things surrounding us, Expressing likes and dislikes, good/bad, possessions. Talking about the country, town and the environment.

Quantity

Number of people, time, period etc., Stating thoughts and impressions. Conveying movement (e.g. go / come)

Sanskrit Language (MS 1401)

Objective: The student will learn the basics of standard Sanskrit language, and will get to know its importance with respect to national unity, integrity, morality and spirituality.

Course outcome

At the end of this course, Students will be

- familiar with the pronunciation of Sanskrit language
- understand ancient scientific concepts, principles, and methodologies without the limitations of translations or interpretations

Introduction to Sanskrit Phonetics

Devanagiri Lipi: Swar and Vyanjan. (Writing rules,Definition,classification,Pronunciation system),Sanskrit Sentence formationand spoken Sanskrit rules.Translation:From Sanskrit to English or English to Sanskrit. Sanskrit Subhashita.

Sanskrit grammar

Sandhi (introduction, classification, Swar-Sandhi),Kāraka&Vibhakti (Definition, Types, Example). Sabdārūpa&Dhāturūpa.

Introductory Vedic & Classical Literature

Four Vedas, Āraṇyakas, Upaniṣads, Vedāṅgas, Purāṇas.Rāmāyaṇa(by Vālmīki) and **Mahābhārata** (by Vyāsa), Bhagavad Gita etc.

Introductory Vedic Mathematics and Sciences in Sanskrit:

Illustrations from book- Vedic Mathematics written by Bharati Krishna Teertha ji, (published by MLBD) –Calculation pi, square root finding, Philosophical meanings of zero and one. Surya Siddhanta. (Kalganana), Katapayadi Sankhya,NāradāŚilpa Śāstra(Architecture and Vastu Shastra), Aṣṭāṅga Hridayam.

Modern Age Possibilities: Sanskrit for ICT : Paper by Subhash Kak and Saroja Bhate Panini's Grammar and Computer Science.

Text Books:

- Sanskrit Sahitya ka Samikshatmak Itihas by Dr. Kapil Dev Dwivedi.

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B.TECH- IT(Bin)

Applicable with effect from 2023 admitted batch and onwards

Engineering Physics (AS1001)

Objective: Students will be able Demonstrate ability to collect, process, and analyze scientific data, display critical thinking skills in applying physics knowledge in the experimental process.

Course outcome

At the end of this course, Students will be able to

- To analyze dynamics of system of particles for applications in Physics and Engg.
- Identify, formulate and solve engineering problems requiring principles of physics
- Gain knowledge about modern physics and quantum mechanics
- Apply quantum physics to understand solid state materials
- Design & conduct experiments, analyze & interpret data

Classical Mechanics

Symmetry and conservation laws, Fermat's principle, Principle of least action, Euler Lagrange equations and its applications, Degrees of freedom, Constraints and constraint forces, Generalized momentum, Concept of phase space, Hamiltonian.

Quantum Mechanics

De Broglie's hypothesis, wave function and wave packets, phase and group velocities. Schrödinger Equation. Probabilities and Normalization, Eigenvalues and eigen functions. Infinite potential well and energy quantization. Finite square well, potential steps and barriers - notion of tunneling, band structure of solid.

Solid State Physics

Energy Bands, Carrier transport in semiconductor, mobility and resistivity, electron effective mass, Density of states, Fermi-Dirac distribution function, intrinsic carrier concentration, Mechanism of carrier scattering, Einstein relationship.

Text Books

- Classical Mechanics; H. Goldstein, C. Poole, J. Safko; Pearson Education, Third Edition (2002)
- Modern Physics by A. Beiser; McGraw-Hill Higher Education, Sixth Edition (2003)
- Introduction to Quantum Mechanics by D. J. Griffiths; Pearson Education, Second Edition (2005)
- Introduction to Solid State Physics by C. Kittel; Wiley Students Edition, (2005)
- Physics of semiconductor devices, S M Sze, John Wiley & Sons, 2006

Reference Books

- Theoretical Mechanics by M. Spiegel; McGraw Hill Education, 2017
- Feynman Lectures of Physics Vol-1 and Vol-3; The Millenium Edition, Pearson (2012)
- Quantum Physics for Atoms, Molecules, Solids, Nuclei and Particles by R. Eisberg and R. Resnick; 2nd Edition, New Delhi Wiley (2012)

Linear Algebra (AS1002)

Objective: Students will be able to solve linear equations & develop understanding of vector spaces, linear transformations, Eigen value, diagonalization and orthogonalization, least square solutions and singular value decomposition etc

Course Outcome

Students will be able to

- Understand the concept of matrices, their properties & solve linear equations
- Understand basic concepts of vector spaces, subspace, linear dependence etc
- Calculate the rank-nullity of a matrix / linear map, eigenvalues, and eigenvectors.
- Apply the Gram-Schmidt process, Find the SVD, Jordan Canonical form .
- Apply concepts of linear algebra to various applications.

Matrices and Vector Spaces

System of linear equation, Gauss elimination method, Elementary matrices, Invertible matrices, Gauss-Jordan method, Determinant, Cramer's rule, Vector spaces, Linearly independence and independence, Basis, Dimension.

Linear transformation & Diagonalizability

Linear transformation, Representation of linear maps by matrices, Rank-Nullity theorem, Rank of a matrix, Row and column spaces, Solution space of a system of homogeneous and non-homogeneous equations, Eigenvalue, eigenvector, Cayley-Hamilton theorem, Diagonalizability, minimal polynomial

Inner product space

Inner product space, Cauchy-Schwarz inequality, Orthogonal basis, Gram-Schmidt orthogonalization process, Orthogonal projection, Spectral theorem.

SVD & Jordan Canonical Form

Positive, negative, and semi-definite matrices. Decomposition of the matrix in terms of projections, Strategy for choosing the basis for the four fundamental subspaces, Least square solutions and fittings, Singular values, Primary decomposition theorem, and Jordan canonical form.

Text/Reference Books

- K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Pearson (2015).
- Gilbert Strang, Introduction to Linear Algebra, 4th Edition, Cambridge Press (2009).
- S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).
- S. Lang, Introduction to Linear Algebra, 2nd Edition, Springer (2012).

Problem Solving with Programming (IT1001)

Objective: Students will be able to understand programming language (in this case C language), develop a problem-solving approach from programmer's perspective.

Course Outcome

Students will be able to:

- break down complex real-world problems into smaller, manageable subproblems and develop logical approaches for solving them through programming.
- learn to debug code, identify and fix logical errors, and write test cases.
- develop a systematic approach to problem-solving, logical reasoning, and iterative refinement.

Introduction to Computers & Demo

Computer hardware, Computer Networks, IP Address, Proxy, Gateway, Operating Systems, Disk/Directory/Files system, Application Software. Professional Ethics.

Programming Basics: Structure of a simple C program, Constants and Variables, Basic Data Types, Precedence and Associativity, implicit and explicit type conversion, Selection Statements, Loop Structures

Functions and Arrays: User-defined functions, function definition, Storage class and Scope, Macros, Nested, and Recursive Functions, One Dimensional arrays, Passing Arguments, Two and higher Dimensional Arrays, Strings, String Library Functions

Pointer and Structure: Addresses and Pointers, Structures, Dynamic Memory Allocation, Linked List, Stack, Queue. Data Files.

Text Books

- "Engineering Problem Solving with C", Delores M. Etter, Fourth Edition, 2012, Pearson.
- "C: How to Program", Paul Deitel and Harvey Deitel, Ninth Edition, 2022, Pearson.

Reference Books

- "Computer Systems: A Programmer's Perspective", Randal E Bryant and David R O'Hallaron, Third Edition, 2015, Pearson.
- "Problem Solving and Program Design in C", Jeri R. Hanly and Elliot B. Koffman, Eighth Edition, 2015, Pearson.
- "Programming in C", Brian Kernighan and Dennis Ritchie, Second Edition, 2015, Pearson.

Fundamentals of Electrical and Electronics Engineering (EC1001)

Objective: Students will be able to understand the fundamental concepts of electrical and electronics engineering.

Course Outcome
Students will be able to:

- Understand working principles of basic electrical and electronic devices and circuits.
- Design basic electronic circuits

Introduction
Basic physical laws, circuit elements, KVL, KCL, Network Theorems

Transients
R-L, R-C, R-L-C, Sinusoidal Steady State, Real/Reactive Power, Three Phase,

Transformers/AC/DC machines
Working Principles of Transformers/AC/DC machines

Semiconductors
Semiconductors, Band Diagram, n-type and p-type semiconductor, junction diode, diode biasing, Zener diode, DC Power supply

Transistors
Introduction to Bipolar Junction Transistor, MOS Capacitor, Introduction to Operational Amplifier, Schmitt Trigger, Multivibrator, Oscillators

Text Book

- Microelectronic Circuits SEDRA/SMITH 7th Edition Oxford University Press
- Fundamentals of Electrical Engineering, Leonard S Bobrow, 2nd Edition, Oxford Press.
- Fundamentals of Electrical Engineering and Electronics, B L Thereja, S Chand Press.

References

- Network Analysis, M E Van Valkenberg, 3rd Edition, PHI, 2000
- Linear Circuit Analysis: Time, Domain, Phasor and Laplace Transform Approaches, R A DeCarlo and M Lin, 2nd Edition, Oxford University Press, 2000

Technical Communication Skills (MS1001)

Objective: Students will be able to enhance and polish communication skills which will formally help them to be effective professionals by understanding importance of effective communication, presentation and designing of work.

Course Outcome
Students will be able to:

- Speak and participate in GD
- Write technical letters, CV, product development plans etc

Introduction
Introduction to types of communication, Lab sessions and mock presentation pertaining to Communication Styles, Content Management and Delivery Making Effective Public presentations, Speech and diction correction and counseling

Formal communication
Written communication, Problems and solutions Lab sessions will have exposure to: Cover letter, CV preparation Group discussion and Personal Interview Report writing and Proposal development plan, Interview: types and techniques SWOT Analysis.

Reference Books

- Winning at Interviews by Edgar Thorpe Books on Technical Writing

Constitution of India (MS1002)

Objective: Students will be able to understand the Fundamental features of the Indian Constitution, Union Government, Rights and Duties, Statutory Institutions.

Course Outcome
Students will be able to:

- Understand Indian Constitution, its composition and functions, Union and state Government
- Understand Rights and Duties, Statutory Institutions etc

Introduction
Evolution of the Indian Constitution, Acts, Fundamental features of the Indian Constitution, Union, State and Local Government.

Rights and Duties
Fundamental Rights and Duties, Directive Principles, Relation between Federal and Provincial units: Union-State relations, Administrative, legislative& Financial, Inter-State Council, NITI Ayog, Finance Commission of India, Union List, State List, Concurrent List, Statutory Institutions: Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

Reference

- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi
- Subhash Kashyap, Our Parliament, National Book Trust, New Delhi
- Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi

Universal Human Values (MS1003)

Objective: Students will be able to understand the human values.

Course Outcome
Students will be able to:

- Understand the importance of human values, family, society, nature etc.
- Develop commitment and courage to act.

Introduction
Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

Self Reflection
Right understanding Strengthening of self-reflection, Development of commitment and courage to act, Method to fulfill the human aspirations: understanding and living in harmony at various levels.

Reference

Professional Ethics (MS1004)

Objective: Students will be able to understand the awareness on Engineering Ethics and Human Values.

Course Outcome
Students will be able to:

- Understand social responsibility of an engineer etc.
- To appreciate ethical dilemma while discharging duties in professional life.

Values
Human Values Morals, Integrity, Work Ethics, Honesty, Courage, Empathy etc. Kohlberg's theory, Gilligan's theory, Models of Professional Roles.

Ethics
Codes of ethics, Challenger case study, Safety and Risk, The Three Mile Island And Chernobyl Case Studies, global issues, moral leadership

Reference

- Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.
- Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
- Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
- Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
- John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

Youth Empowerment and Skills (MS 1005)

Objective: To equip students with practical tools and techniques that will make them more creative, efficient, confident, clear-minded, stress-free, joyful and energetic

Course Outcome
Students will be able to:

- learn challenges and will learn group processes, talks, presentations and hands-on learning methodology that helps students to enhance their lives.
- Participate in Group discussions and role-plays to inculcate life-skills and human values
- Yoga Asanas and Pranayama to increase concentration & build confidence
- Breathing techniques (like the world-renowned and well-researched Sudarshan KriyaTM)
- Talks and Presentations to bring out attitudinal and behavioral changes towards achieving student excellence.

Personality Development
Personality Development Self-awareness, Emotional Intelligence / Coping with Emotions, Mind Management, Coping with Stress, Health and Nutrition, Social Adaptability and Effectiveness Effective Communication Skills, Interpersonal Relationship Skills, Lifestyle and Environment

Ethics
Ethics, Morality and Integrity, Time Management and Goal Setting, Professional Skills, Active Learning and Effective Learning Strategies, Decision Making

Reference

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Computer Organization and Architecture (IT1002)

Objective: To make student learn the basic concepts of computer architecture and organization, and understand the key skills of constructing cost-effective computer systems**.**

Course Outcome

- To understand the basic operations of computing hardware interface and system-level programming, compilers, assemblers, instruction sets etc.
- Understand merits/demerits for performance, design process of a computer, memory hierarchy, cache design, microprocessor designs etc.

Introduction

Basic organization of computer and block level description of the functional units; Review of Digital Systems, Memory system design, FSM, Fixed and Floating-point data.

Computer Arithmetic and Design of ALU

Integer Data computation, Floating point arithmetic, Design of 8/16/32 bit ALU

CPU Architecture

Register Organization, Instruction formats, Instruction interpretation and Sequencing, RTL, addressing modes, instruction set. Case study - instruction sets of MIPS processor and ARM.

Assembly language programming

ARM instruction set, Introduction to Memory and Memory parameters. Classifications of memories, Allocation policies, Memory hierarchy and interleaving

Cache memory

Concept, architecture, mapping techniques. Virtual Memory, Page replacement policies. Data Path and Control Unit design, Memory, bus structure, hardwired and microprogrammed design approaches, Case study - design of a simple CPU

I/O Organization and Peripherals

I/O subsystems, DMA, privileged and non-privileged instructions, software interrupts & exceptions. Assessing and Enhancing Performance of Computer Systems; Pipelining, hazards, Flynn's classifications, Architectures - Multi-core systems, GPU

Text Book

- David A. Patterson and John L. Hennessy, Computer Organization and Design: The Hardware/Software Interface Morgan Kaufmann ARM Edition, 2010.

Reference Book

- C. Hamachar, Z.Vranesic and Safwat Zaky, Computer Organization, McGraw Hill
- William Stallings, Computer Organization and Architecture: Designing for Performance, Pearson Education
- John P. Hayes, Computer Architecture and Organization, McGraw Hill
- Morris Mano, Computer System Architecture, Pearson Education

Data Structures and Algorithms (IT1003)

Objective: To make student learn the linear and non-linear structures in which data can be stored and their pros and cons & to write algorithms using different data structures.

Course Outcome

- Understanding of data structures, linked-lists, trees, binary search trees, AVL trees, stacks, queues, priority queues, and hash-tables and graphs, ADT
- To apply & implement learned algorithm design techniques and data structures to solve problems.

Introduction, Arrays and Linked Lists
Basic Terminology, Elementary Data Organization, Asymptotic notations Efficiency of an Algorithm, Time and Space Complexity and trade-off**,** Single and Multidimensional Arrays, Sparse Matrices, Single, Double and Circularly Linked List, Header node based Linked List, Operations on a Linked List. Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List

Abstract Data Types (ADT), Searching and Sorting, **Priority Queues**
Stacks: Primitive Stack operations (Push & Pop) Implementation and Application of stack, Queue Implementation and Applications, Doubly Ended Queue, Sequential search, Binary Search, Comparison Sorting Techniques, Efficient Sorting Techniques, linear sorting techniques, Queue Definition & Implementation.

Hashing, Trees & Graphs- Hash table, hash function, collison & resolution strategies, Linear and Quadratic Probing, Trees, Binary Tree Representation, Expression Tree, Binary Tree Traversals, Binary Search Trees, Sequential & linked Representations of Graphs, Adjacency Matrix, Adjacency List, Graph Traversals, Connected Components, Minimum Cost Spanning Trees, Prims & Kruskal algorithm, Dijkstra algorithm

Text Books

- E. Horowitz, S. Sahni, S. Anderson-Freed “Fundamentals of Data Structures in C”, Second Edition, 2008, Universities Press.
- R. Kruse et al. , *Data Structures and Program Design in C,* Pearson Education
- S. Lipschutz , *Data Structures, Schaum's Outlines Series,* Tata McGraw-Hill.
- Mark Allen Weiss, “Data Structures and Algorithm Analysis in C (DSAC)”, Second Edition, 2002, Pearson Education India.

Reference Books

- “Algorithms Design”, Jon Kleinberg and Eva Tardos, First Edition, 2013, Pearson.
- “The C Programming Language”, Brian W. Kernighan and Dennis M. Ritchie, Second Edition, 2015, Pearson Education India.
- “Introduction to Algorithms”, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, Third Edition, 2009, MIT Press.

Web Development (IT1004)

Objective: To make students aware about the latest technologies in Web development and to give hands-on exposure on web development technologies.

Course Outcome
Students will be able to:

3. learn about the latest technologies in web development and get hands-on exposure on web development technologies.
4. to use the web application frameworks in web development and to deploy the modern web development tools and techniques.

Introduction to Web Development
Overview of web technologies, Web development tools and environments, HTML (Hypertext Markup Language), Working with text, links, images, and tables, Semantic HTML and accessibility, HTML forms and input validation, multi-page websites.

CSS (Cascading Style Sheets) & JavaScript
CSS and its role in web design, CSS selectors, properties, and values, Layout and positioning of HTML elements, Responsive design and media queries, JavaScript syntax, variables, and data types, Control structures, DOM manipulation and event handling, JavaScript frameworks/libraries, Backend Development, server-side programming & language, Handling HTTP requests/responses, Working with databases

Web Application Frameworks, Security and Deployment
Web application framework, frontend frameworks, State management and data binding, web vulnerabilities, Best practices for secure web development, User authentication and authorization, Optimization, Techniques for improving website performance, Web Deployment and Hosting, Setting up a web server, Deploying web applications.

Text Books

- Jon Duckett “HTML and CSS: Design and Build Websites”, First Edition, 2011, John Wiley & Sons
- Jon Duckett “JavaScript and jQuery”, First Edition, 2014, Wiley.

Reference Books

- “The Web Developer Bootcamp", by Colt Steele
- “Modern JavaScript from The Beginning 2.0 - 2023 Revamp
- The Complete Web Developer Course 3.0
- Web Design for Everybody: Basics of Web Development & Coding by University of Michigan

Discrete Mathematical Structures (IT1005)

Objective: To make student learn the fundamental mathematical concepts and terminology for discrete mathematics and structures.

Course Outcome

Students will be able to

- Understand logic and proof techniques
- Apply the above techniques in counting and solving recurrence relations
- Analyze real-world models using graph theory
- Extend their usefulness in succeeding courses in algorithm design and analysis, computing theory, software engineering, and computer systems

Methods of Proof, Logic & Proofs

Proof by contradiction, Proof by induction-weak and strong induction, Structural induction, Proof by proving the contrapositive, Proof by cases, and Proof by counter-example. Logic. Propositional Logic, Truth tables, Deduction, Resolution, Predicates and Quantifiers, Mathematical Proofs. Infinite sets, well-ordering. Countable and Uncountable sets, Cantor's diagonalization.

Sets and Sequences

Finite Sets, Power Set, Cardinality of finite sets, Cartesian Product, Properties of Sets, Vector Implementations of Sets.

Counting & Combinatorics

Counting, Sum and product rule, Principle of Inclusion Exclusion. Pigeon Hole Principle, Counting by Bijections. Double Counting. Linear Recurrence relations - methods of solutions. Generating Functions. Permutations and counting.

Relations, Graphs & Algebraic Structures

Relations, Equivalence Relations. Functions, Bijections. Binary relations, Posets and Lattices, Hasse Diagrams, Boolean Algebra, and Graphs and Trees. Structured sets with respect to binary operations. Groups, Semigroups, Monoids. Rings, and Fields.

Text Books

- Discrete Mathematics and its Applications, Kenneth H. Rosen, 7th Edition -Tata McGraw Hill Publishers, 2011.
- Mathematics for Computer Science, Eric Lehman; F Thomson Leighton; Albert R Meyer, 2010.

Reference Books

- Logic in Computer Science, Huth and Ryan, Cambridge University Press, 2014.

Essentials of Business Information (IT1600)

Objective: In this course, students will acquire the introductory and key aspects of business informatics. The theoretical foundations, methodologies and tools will also be introduced in this introductory course

Course Outcomes
The students will be able to:

- Have a good understanding of the basic concepts of Process Mining.
- Understand the role of Data Science in Today's Life.
- Have a good understanding of the data needed to start a process mining project.

Information Technology and the Modern Enterprise
Technical Foundation of Business Informatics: IT influence on Businesses, IT influence on Finance, Marketing, HR, Operations etc. Overview and Introductory concepts: Fin Tech, Digital Marketing, Digital Transformation with BPM, Case Studies.

Information Systems
Characteristics & Components, Types of IS: MIS, ERP, Managing Digital Firms: Global E-business and Collaboration. IT Infrastructure and Emerging Technologies: Evolution of Web, Client-Server to Distributed Computing, Cloud Computing, Emergence of Mobile Digital platform: Mobile Apps, Data driven systems, Transactional data, Operational data and data for Machine Learning: Characteristics and Use Cases.

Data Science Vs Process Science
Introduction to BPM (Business Process Management), Characteristics of Business Process, Types of Business Processes, Bottlenecks of Business Processes, Business Process Mining Introductory concepts.

E-Commerce& AI driven Business
History and evolution Key business models: B2B, B2C, C2C, D2C, E-commerce infrastructure and technology stack Supply Chain & Logistics. Recent trends in AI for Businesses.

References Books:

- Basics of Business Informatics by Peter Weber, Roland Gabriel • Thomas Lux • Katharina Menke Springer-Vieweg, Berlin, 2021
- Information Systems: A manager's Guide to Harnessing Technology (Version 9.0) by John Gallaugher-Flat World.
- MIS-Managing the Digital Firm (13th Edition) by Kenneth C Laudon. Jane P. Laudon.(Pearson)

Principles of Management (MS1006)

Objective: This course is designed to be an overview of the major functions of management. It explores how organizations develop and maintain competitive advantage within a changing business environment. Upon completion, students should be able to work as contributing members of a team utilizing these functions of management.

Course Outcome

Students will be able to

- Understand how organizations adapt to an uncertain environment and identify techniques managers use to influence and control the internal environment.
- Practice the process of management's four functions: planning, organizing, leading, and controlling.

Nature and Functions of Management

Importance and Process of Management, Development of Management Thoughts, Managerial Roles.

International Business and its Environment

Globalization & WTO, Dynamics of development Global business environment, Internal Tech. of Forecasting.

Need for Organization

Principles and Process of Organizing, Authority, Delegation and Decentralization

Staffing and Directing

Requirement of Effective Direction

Text Book

- Koontz, Weihrich, Aryasri. Principles of Management, TATA McGraw Hill, New Delhi, 2004.

References

- P. C. Tripathi, P. N. Reddy, Principles of Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Prasad LM, Principles and Practice of Management, Sultan Chand & Sons, New Delhi.
- Samuel C. Certo, S. TrevisCerto, Modern management 10 Ed, PHI Learning, New Delhi, 2008
- James A. Stoner, Edward Freeman, Daniel Gilbert, Management, PHI Learning, New Delhi, 2007
- Williams/ Kulshrestha, Principles of Management, Cengage Learning, New Delhi, 2011

Environmental Studies (MS1007)

Objective: To make student learn the importance of environmental studies, different resources, ecosystem etc.

Course Outcome

Students will be able to

- Understand the Multidisciplinary nature of environmental studies.
- Structure and function of an ecosystem
- Environmental Pollution etc.

Nature of Environmental studies, Ecosystems

Definition, Scope and importance, Need for public awareness. Different resources, Concept of an ecosystem, Structure and its function, Food chains, Different eco systems, Biodiversity, Threats, In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution & Field Work

Causes, effects and control measures of different pollution, Nuclear hazards, Pollution case studies, Disaster management, Water conservation, rain water harvesting, watershed management, Case studies on Environmental ethics, Climate change, global warming, Case studies. - Wasteland reclamation, Environment Protection Act, Water Act, Wildlife Protection Act, Visit to a local polluted site and Study of ecosystems.

References:

- Agarwal, K.C.2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt.Ltd. , Ahmedabad — 380 013, India, Email: mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc.480p
- Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
- Cunningham, W.P.Cooper, T.H.Gorhani, E &Hepworth, M.T.2001. Environmental Encyclopedia, Jaico Publ. House. Mumbai, 1196p
- Dc A.K., Environmental Chemistry, Wiley Eastern Ltd.
- Down to Earth, Centre for Science and Environment(R)
- Gleick, 11.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press. 473

Physical Education (Sports) (MS1008)

Objective: To aware the students on the importance of physical education for a healthy life and train them on various sports, games, yoga, etc. for physical fitness.

Course Outcome

Students will be able to

- Understand the knowledge of various ways for maintaining both physical and mental wellness

Know your body

First Aid for basic medical conditions, CPR for emergency, Diabetic and Obesity condition of Indian and world, Importance of physical education.

Yoga and Meditation

Yoga for wellness and concentration, Meditation for wellness

Athletics and Aquatics

Rules, benefits and mastering of various track and field events such as Sprint, Marathon, Hurdles, Long Jump, High Jump, Javelin throw, Shot Put, Discus throw, etc.

Rules, benefits and mastering of various styles of swimming, butterfly, freestyle, backstroke, and breaststroke, Sports for physical fitness like Cricket, basketball, football, volleyball, etc.

References:

- Dr. V K Sharma, “Health and Physical Education”. New Sarasvati House Publishers.
- “Yoga: A Healthy Way of Living”. By National Council of Educational Research and Training.
- Mark Young. “The Complete Beginners Guide to Swimming”.
- Dr. Ashwini Bhardwaj. “A Complete Guide to Family Safety and First Aid”. GoodWill’s Publishers.

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Probability and Statistics (AS2001)

Objective: This course provides an elementary introduction to probability and statistics with applications. The topics covered in this course are basic concept of probability and statistics, random variables, probability distributions, Bayesian inference, joint probability distributions, random vectors, central limit theorem, confidence intervals.

Course Outcome
Students will be able to:

- Understand the basic concepts of probability and random variables.
- Apply the standard discrete and continuous probability distributions to real problems and use the inequalities.
- Extend the concept of random variables to higher dimensions and approximate probabilities by central limit theorem.
- Analyze the data by using statistical techniques of point and interval estimation and testing of hypotheses.

Probability: Axiomatic definition, Properties, Conditional probability, Bayes rule and independence of events, Random Variables, Distribution function

Probability Distributions: Discrete and Continuous random variables, Expectation, Function of random variable, Moments, Moment generating function, Chebyshev's and Morkov's inequality. Bernoulli, Binomial, Geometric, Negative binomial, Hypergeometric, Poisson, Discrete uniform, Continuous uniform, Exponential, Gamma, Normal.

Random vector: Joint distributions, Marginal and conditional distributions, Moments, Independence of random variables, Covariance, Correlation, Levy's Central limit theorem (independently and identically distributed with finite variance case), Normal approximation to Binomial and Poisson

Statistics: Introduction: Population, Sample, Parameters, Point Estimation: Method of moments, Maximum likelihood estimation, Unbiasedness, Consistency, Interval Estimation: Confidence interval, Tests of Hypotheses, Linear Regression.

Text/Reference Books

- Sheldon M. Ross, An Introduction to Probability Models, 10th Edition, Academic Press, Elsevier.
- Sheldon M. Ross, An Introduction to Probability and Statistics for Engineers and Scientists, 3rd Edition, Academic Press, Elsevier.
- Rohatgi, V. K. and Saleh, A. K. (2000), An Introduction to Probability and Statistics, 2nd Edition, Wiley-interscience.
- Bertsekas, D. P. and Tsitsiklis, J. N. (2008), Introduction to Probability, Athena Scientific, Massachusetts.

Object Oriented Methodologies (IT2001)

Objective: To learn the concept of Object Orientation and its applicability in modeling real life scenarios and to get acquainted with UML Diagrams and Object Oriented Analysis Processes, and concepts like data abstraction, encapsulation, inheritance etc.

Course Outcomes

Students will be able to

5. Understand and apply the object-oriented approach in software development.
6. Optimize the codes by applying the concepts of modularity, reusability etc.
7. Design Java programs to model real-world systems and analyze their behavior using object-oriented principles and create models for software design using Unified Modeling Language (UML).
8. Apply Design principles for a flexible, maintainable software design

Introduction

Characteristic differences between Procedural and Object Oriented approach for programming, Concepts of Class, Objects, and Object Oriented Characteristics. Building upon basic programming skills in OO, specifically using basic Java programming constructs for object-oriented problem solving (e.g., Classes: Abstraction, inheritance, interfaces, polymorphism), Methods in OO Programming: Method overloading and overriding.

Models

Design and analysis of larger, more complex programs using Object Oriented Modeling with UML. Need for models, Static and Dynamic modeling diagrams, and role of Use Case Diagrams. Role of Object orientation in problem solving, Java program to model a real world system, and subsequently analyze its behavior. Java implementation for GUI, Event handling and Applets for Web enabled applications. Developing Applications with GUI and Database connectivity.

UML

Overview of UML, Class Diagrams Object Diagrams. Sequence Diagrams, Collaboration Diagrams, Static Diagrams: Working with Diagrams and role of Modeling, Making Effective use of UML, Communicating with Others, Back end documentation What to keep, and What to throw away, Iterative Refinement Behavior, Iterative Refinement Minimalism, Object Oriented design Principles & Intro to Design Patterns.

Text Books:

- H. Schildt, Java 2: A Complete Reference 4th ed, McGraw-Hill, 2001
- G. Booch, Object-Oriented Analysis and Design with Applications 2nd Edition, PHI, New Delhi, 1993

Foundation of Fin Tech (IT2600)

Objective: To provide an understanding of the historical development and transformation of FinTech, and to examine the principles and applications of crypto-currencies, blockchain technology, and alternative finance models.

Course Outcomes

Students will be able to

- Understanding history, opportunities, and challenges of FinTech.
- Exploring innovative products and business models.
- Navigating legal and regulatory issues and AI role and data protection in digital finance and applying data analytics for finance.

Introduction & History of Data Regulation:

FinTech Transformation, FinTech Evolution 1.0, FinTech Evolution 2.0, FinTech: Opportunities and challenges, Rise of new TechFins, Innovative products in mobile-based, person to person, credit cards, pos based ecosystem.

Cryptocurrencies and Blockchain: Alternative Finance; Developing Countries and DFS: The Story of Mobile Money; Developing Countries and DFS: Regulation of Mobile Money; Legal and Regulatory Implications of Cryptocurrencies; ICO (Initial coin offering)

Digital Finance: A Brief History of Financial Innovation; Digitization of Financial Services; Crowdfunding; FinTech & Funds, Case study of FinTech startups; FinTech ecosystem, players, processes, modes and various charges; FinTech Regulations; Challenges of Data Regulation; Innovation in consumer and retail payments led by govt & private sector; new payments banks

AI is Transforming the Future of FinTech: Governance; New Challenges of AI and Machine Learning in finTech; AI in Smart Regulation and Fraud Detection; Redesigning Better Financial Infrastructure-case studies; Data in Financial Services Application of Data Analytics in Finance; Methods of Data Protection: GDPR Compliance and Personal Privacy; Digital Identity; Case studies on data-driven finance- Alibaba, Aadhar, Paytm, BHIM etc.

Text Books:

- The Fintech Book: The Financial Technology Handbook for Investors, Entrepreneurs and Visionaries by Susanne Chishti
- Digital Bank: Strategies to launch or become a digital bank (Kindle Edition by Chris Skinner
- Fintech in a Flash: Financial Technology Made Easy by Agustin Rubini
- The Business Blockchain: Promise, Practice, and Application of the Next Internet Technology by William Mougayar

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Operating Systems (IT2003)

Objective: To make student learn the design and services provided by an operating system particularly xv6 operating system.

Course Outcome
Students will be able to:

- Understand operating systems
- Memory management, input-output and storage management
- concept of distributed systems, OS Systems security etc.

Introduction, System Calls & Process and Thread Management
OS Basics, Definition, Operating Systems as resource manager, Evolution of OS, Structural overview, Types of System Call, Hardware requirements, Process Model, Process States, Operation on Process, System calls for process operations, Overview of Threads, Multithreading Models, Threads and their Management; POSIX Threads, Implementing Threads in User space and Kernel space

CPU Scheduling, Interprocess Comm., Process Synchronization & Deadlocks
Scheduling Criteria & Algorithms, Multiple-Processor Scheduling, Concept of shared memory, message passing, pipes, The Critical-Section Problem, Peterson's Solution, Synchronization, Semaphores, Problems of Synchronization, Dynamic Resource Allocation, Deadlock Characterization, Prevention, Avoidance, Detection, Recovery

Memory Management, Input Output and Storage Management, File Management
Main Memory Basics, Swapping, Contiguous Memory Allocation, Paging, Structure Segmentation, Virtual Memory, Demand Paging, Page Replacement, Allocation of Frames, Thrashing, Principles of I/O hardware, I/O Software Layers, Mass-Storage Structure, Disk Scheduling & Management, File Concept, Protection, Mounting, Sharing, Structure, Implementation, Directory Implementation, Allocation Methods

Advanced Topics
Multiprocessor Hardware and OS, scheduling and synchronization, multicomputer hardware, distributed shared memory, remote procedure call, concept of distributed systems; OS Systems security, controlling access to resources, exploiting software

Text Book

- R H. Arpaci-Dusseau and A C. Arpaci-Dusseau “Operating Systems: Three Easy Pieces”, Arpaci-Dusseau Books, November, 2023 (Version 1.10)

Reference Book

- P. B. Galvin and G Gagne “Operating System Concepts”, Abraham Silberschatz, 8th Edition, 2008, Wiley.
- A S. Tanenbaum and H Bros “Modern Operating Systems” 4th Edition, 2015,
- W Stallings “Operating Systems: Internals and Design Principles”, Prentice Hall

Software Engineering (IT2004)

Objective: To apply software engineering theory, principles, tools and processes, as well as the theory and principles of computer science and mathematics, to the development and maintenance of complex, scalable software systems

Course Outcome

Students will be able to:

- Understand and apply software lifecycle development models to effectively manage the software development process and
- utilize software design principles and modeling to develop scalable and maintainable software systems.
- Develop and implement project plans, apply metrics for measurement, estimate costs etc in software project development to ensure quality.

Introduction to Software Engineering

Software characteristics, Software components, Software applications, Software Engineering Principles, Software metrics and measurement, monitoring and control. Software development life-cycle, various model and recent developments in models.

Requirements

Elicitation Techniques, Requirements analysis, Modeling and Architecture, Functional versus object-oriented approach of design, design specification, Cohesiveness and Coupling. Overview of SA/SD Methodology, structured analysis, UML diagrams. Data flow diagrams (DFDs), extending DFD to structure chart.

Software project Planning

Project scheduling. Software Metrics: Size Metrics, Cost estimation using models like COCOMO. Risk management, Software Reliability and Quality Assurance: Reliability issues, Reliability metrics, reliability models, Software quality, ISO 9000 certification for software industry, SEI capability maturity model, Client server software development.

Verification and validation

Code inspection, test plan, test case specification. Level of testing, Various testing Top down and bottom-up integration, Alpha and Beta, System and debugging, functional structural testing, Software testing strategies, Software reliability and quality, Software maintenance and reuse, Structured Vs unstructured maintenance, Maintenance Models, Configuration Management, Reverse Engineering, Software Re-engineering.

Text Books

- Sommerville “Software Engineering”, Tenth ed, 2016, Pearson Education .
- R S. Pressman & B R. Maxim “Software Engineering: A practitioner’s approach”, Eighth Edition, 2014, Mcgraw-Hill.

Reference Book

- W. S. Jawadekar “Software Engineering: Principles and Practice”, 2004, Tata McGraw-Hill Education.

Introduction to Finance (MS2002)

Objective of the Course: This course is a rigorous introduction to the study of the basic principles of finance and their application to the usual financial issues and decision-making of business enterprises. The main objective of this course is for the student to obtain at least a good working-knowledge of the topics stated in the tentative course outline below for use in future courses and for careers.

Course Outcome
Students will be able to:

- Identify the objective of the firm and the role of managerial finance.
- Outline the implications of the separation of ownership and control.
- Evaluate financial statements using ratio analysis.
- Explain the general concept of valuing financial assets.
- Explain the characteristics of debt and equity securities.
- Identify why firms need to invest in working capital Outline the alternative sources of long-terms fund.

Introduction to financial Management
Financial statement basics, Ratio Analysis

Time value of Money
Capital Budgeting, Relationship between risk and return

Long term financial decisions
Working Capital Management, Dividend Decision

Introduction to Financial Systems
Capital Markets, Introduction to International finance and risk Management

Text Books ·

- Ross, Westerfield, Jordan, Essentials of Corporate Finance
- James C. Van Horne and John M Wachowicz, Fundamentals of financial management.
- Jonathan Berk, Financial Management

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Design and Analysis of Algorithms (IT2005)

Objective: To analyze the asymptotic performance of algorithms, Write rigorous correctness proofs for algorithms and to demonstrate a familiarity with major algorithms and data structures.

Course Outcome

Students will be able to:

- Demonstrate the ability to fully understand the analysis of various known algorithms.
- Identify problems where algorithm design paradigms can possibly be applied.
- Explain graph algorithms and their analysis and to understand the notions of computational intractability and learn how to cope with hardness
- Synthesize efficient algorithms in common engineering design situations.

Introduction

Basic concepts, Growth of Functions – Asymptotic Notations, Tradeoff between Time and Space Complexities, Searching and Sorting - Sorting in Linear Time

Divide and Conquer & Randomized Algorithms

Definition, Designing, Analysis, Proof of Correctness, Recurrence Relations, Master's Theorem, Definition, Designing, Analysis, Proof of Correctness

Dynamic Programming & Greedy Algorithms

Definition, Designing, Analysis, Proof of Correctness, Longest common subsequence, Optimal Binary Search Trees, Matrix Chain Multiplication, Definition, Designing, Analysis, Proof of Correctness, Interval scheduling, Huffman tree, Knapsack problems

Graph Algorithms & Complexity classes

Traversal, Topological sort, Minimum Spanning Tree, Single Source Shortest Path, All Pairs Shortest Path, Maximum Flow, P, NP, NP-Complete, NP-Hard

Approximation Algorithms

Definition, Designing, Analysis, Proof of Correctness, Vertex cover problem, Travelling Salesman problem, Subset Sum Problem,

Text Books

- T H Cormen, C E Leiserson, R L Rivest, and C Stein E, Introduction to Algorithms, MIT Press, 4th edition, 2022.

Reference Books

- J Kleinberg, and E Tardos, Algorithm Design, Pearson, 1st edition, 2013

Operation Research (MS2601)

Objective: To grasp the fundamental concepts and techniques of operations research and to develop skills in formulating and solving linear and nonlinear optimization problems.

Course Outcomes

Students will be able to:

- Explore methods for decision-making under uncertainty and risk
- Apply operations research techniques to real-world business and IT problems to improve efficiency and decision-making
- Develop proficiency in solving LP problems using graphical, algebraic, simplex methods.

Linear Programming

Terminology and formulations, Graphical and Algebraic solutions to LP, Simplex methods and its variants: Algebraic form, Tabular form, Types of LPs, Matrix method, Duality: Writing the dual of an LP, Primal-Dual relationships.

Dual

Basic understanding, significance, interpretation, Dual Simplex algorithm

Problem

Transportation Problem, Assignment Problem, Solving LPs using Solver, Sensitivity analysis, Game theory: Two Person Zero-Sum Game, Theorems of Game Theory, Solution of Mixed Strategy Games, Linear Programming method for solving games,

Text Books:

- "Operations Research: Principles and Applications" by G.Srinivasan, PHI Learning Private Limited.
- "Operations Research: An Introduction" by Hamdy A. Taha, Pearson.
- "Operations Research: Principles and Practice" by Ravindran, Phillips and Solberg, Wiley India
- "Operations Research: Concepts and Cases" by Hillier and Liberman, McGraw-Hill

Computer Networks (IT2007)

Objective: To grasp the fundamental concepts of computer networking, including the OSI model, TCP/IP protocol suite, network topologies, and addressing schemes and to learn about various networking protocols and technologies.

Course outcomes
Students will be able to:

- Explain the fundamental concepts of computer networking, including the OSI model, TCP/IP protocol suite, network topologies, and addressing schemes.
- Apply various networking protocols and technologies, such as Ethernet, TCP, IP, UDP, HTTP, DNS, DHCP, etc.
- Use network management principles & to Assess network problems systematically and implement effective solutions.
- Use emerging networking technologies such as SDN, NFV, and IoT

Introduction to Computer Networks
Evolution of computer networks, networks topologies. Layering and protocols.

Physical Layer & Data link layer: Different types of transmission media, errors in transmission: attenuation, noise. Repeaters. Encoding (NRZ, NRZI, Manchester, etc. Error detection, Sliding Window, Stop and Wait protocols, Framing, HDLC, PPP, Channel Access Protocols, Token Ring, Wireless LAN, Virtual circuit switching.

Network Layer & Transport Layer: Internet addressing, Internet Protocol (IPv4, IPv6), ARP, ICMP, DHCP, Internet QoS, routing algorithms (RIP, OSPF, BGP), Software Defined Networking, UDP, TCP, Connection establishment and termination, Sliding window revisited, Buffer Management and Congestion Control at the Transport Layer, Timers, Retransmission.

Session, Presentation, and Application Layers: DNS, SMTP, IMAP, HTTP, etc.

Text Books:

- S. Tanenbaum, Computer Networks, 4th Ed, Pearson India, 2003.
- L. L. Peterson and B. S. Davie, Computer Networks: A Systems Approach, 4th Ed, Elsevier India, 2007.

Reference Books:

- J. F. Kurose and K. W. Ross, Computer Networking: A Top Down Approach, 3rd Ed, Pearson India, 2005.
- D. E. Comer, Internetworking with TCP/IP Vol. 1, 5th Ed, Prentice Hall of India, 2006.
- B. Forouzan, Data Communications and Networking, 5th Ed, Tata Mcgraw Hill, 2013.

Digital Marketing (MS2602)

Objective: To introduce the fundamental concepts of digital marketing and the evolving media landscape and to examine the impact and advantages of digital media over traditional media in today's marketing plans.

Course Outcomes
Students will be able to:

- Design and execute effective digital marketing strategies, incorporating audience targeting content creation and social media marketing.
- Analyse digital marketing performance using web analytics tools to optimize campaigns and improve ROI.
- Leverage SEO, SEM, and social media to build brand presence and engage target audiences across digital platforms.
- Plan and manage digital advertising campaigns on different platforms Understand business and revenue models in the digital space,

Fundamental
Fundamental Marketing Concepts, 7D of digital marketing, RACE concept, Digital audience, Digital device, digital marketing goal and strategy.

Models
Business model, revenue model, online marketplace, digital branding and marketing mix, types of digital media.

Design
Website design, CMS platform, and types, social media marketing, content marketing-mail marketing, Google keyword planner, Google trend.
Analytics
Google analytics, web analytics, Facebook and LinkedIn analytics, blog site designing, and tracking.
Google ad words, campaign planning, cases.
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References Book:

- "Digital Marketing: Strategy, Implementation and Practice" by Dave Chaffey and Fiona Ellis-Chadwick
- "E-Marketing" by Judy Strauss, Raymond Frost, and Alexa Fox
- "Digital Marketing Excellence: Planning, Optimizing and Integrating Online Marketing" by Dave Chaffey and PR Smith
- "Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation" by Damian Ryan

Database Management System (IT2009)

Objective: The main objective of this course is to provide students with the background to design, implement, and use database management systems.

Course Outcomes
Students will be able to:

- Apply knowledge of database techniques to develop relational models and identify and define the information needs and requirements appropriate to its' business context and solution.
- Use current relational database techniques, skills, and tools necessary for developing information systems.
- Develop the ability to explore recent advances like NoSQL and Linked data principles etc. along with applications towards data warehousing & data mining.

Database Systems
Introduction of Data Base systems, User Categories and Architecture, Data Abstraction and Independence. Data Modeling, Mapping Cardinalities, Generalization, Specialization and Aggregation, Case Study ER Diagrams.

Basic of SQL, **SQL & PL/SQL**
Overview of Query Language, SQL, Queries, Relational Model, Concepts of Keys, Weak Entity, Surrogate Keys, CODD Rules, Anomalies in Relational Model, Mapping from ER Model to Relational Model, Data Manipulation Language and DDL Operations, Set Operations, Aggregate Functions, Nested Subqueries, Modification of the Database, PL/SQL, Data Types, Program structure, Embedding SQL statements, Using conditional statements and loops, Functions and Procedures, Cursor, Triggers.

Relational Algebra & Transactions and Concurrency Control
Basic & Extended Operators, Joins, nested query in DBMS, Tuple Relational Calculus, Relational Database, Functional Dependencies, Attribute Closure, Canonical Cover, Decomposition, ACID Properties, Transaction Atomicity, Durability, Isolation, Serializability, Schedule, Isolation Levels. Lock-Based Protocols, Deadlock Handling, Multiple Granularity, Timestamp based Protocols, Index Locking, Recovery.

Query Processing
Overview, Measuring Query Cost, Selection Operation, Sorting, Join Operation, Query Optimization, Transformation of Relational Expressions, etc. Storage and File structure

Text Books

- Silberschatz, Korth and Sudarshan, Database System Concepts, McGraw-Hill.

Reference Books

- R Ramakrishnan, and J Gehrke, Database Management Systems McGraw-Hill.
- R E, Shamkant B. Navathe, Addison-Wesley, Fundamentals of Database Systems (6th ed.)

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Cyber Security (IT 3001)

Objective: The course is outlined with the objective to inculcate necessary skill, education and abilities among the students in the sphere of cyber security

Course Outcome:
Student will be able to:

- Model attack vectors & defense control in confidentiality, integrity and availability.
- Implement Symmetric & Asymmetric cryptographic algorithms & Test the security of the web application, Vulnerability Assessment and Penetration Testing.
- Design and Secure the Network Infrastructure by implementing IDS, Firewalls and Analysis of Malware to find out Indicator of Compromise.

Introduction and basic terminology
Cyber Security and CIA Triad, basic cyber threats to CIA, cyber-attack surfaces, recent cyber-security incidents and their high-level analysis

Basic Cryptography & Authentication, Authorization and Privilege
Role in confidentiality for data at rest, motion, process. Symmetric and Asymmetric Cryptography, Hashing and Digital Signature and some example, understanding digital signature, Digital Certificate and PKI., role of PRNG, strong Authentication, distinction between authorization and authorization, access control, Mandatory and Discretionary Access control, role based authorization, privilege and privilege escalation.

Application Security
Method of Reconnaissance, Port Scanning and Enumaration. Stages of Vulenaribility Assessment. Owasp Model. Basic application vulnerabilities, Basic mitigations of buffer overflow, Web Client Security, DOM, Java Script Vulnerability, Cookies and Cookie attributes Secure, http only, session and session ID, hijacking, http vs. https and SSL/TLS and version issus, XSS, CSRF, SQL Injection, Command Injection concepts, Vulnerabilities in DNS, Routing and IP protocols & suggested remedies.

Perimeter protection & Network Security
Host Intrusion Detection techniques, Network Intrusion Detection, Snort, Firewall vs. Intrusion Detection tool, Firewall rules and customization techniques. Various malware classes and their characteristics, static & dynamic analysis, Signature vs. behavioral detection., WEP, evil twin attack, unauthorized access point based attacks.

Text Book

- J. Anderson "Security Engineering"Ross, Security Engineering, 3rd Ed. Wiley,
- William Stallings "Cryptography and Network Security" 7th Ed. Pearson,

References

- D Stuttard and M Pinto "The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws" , 2nd Edition, ISBN: 978-1118026472.
- Peter Kim, The Hacker Playbook: Practical Guide To Penetration Testing (vol. 1 and 2) by. Third Edition, ISBN: 978-1980901754

Introduction to Machine Learning (IT3002)

Objective: This course gives an introduction to machine learning. It is about unified understanding of the models and algorithms used in machine learning.

Course Outcomes
Students will be able to:

- Understand Core Concepts of Machine Learning, comprehend the fundamentals of supervised, unsupervised, and reinforcement learning and their applications.
- Develop Predictive Models and implementation of different algorithms.
- Optimize Learning Models and apply optimization techniques.
- Analyze and Evaluate Models and to perform model evaluation
- Explore Dimensionality Reduction and Latent Models and to gain foundational knowledge of deep neural networks and reinforcement learning.

Course Logistics and Introduction to Machine Learning
Supervised learning, Decision Trees for Classification and Regression, Random Forest, Bagging, Boosting, Linear Regression, Learning via Probabilistic Modeling

Probabilistic Models for Supervised Learning
Discriminative and Generative Approaches, Basics of Convexity, Gradient Descent, Stochastic GD Hyperplane based Classifiers (Perceptron and SVM) SVM (Contd), Multiclass and One-Class SVM Making Linear Models Nonlinear via Kernel Methods

Intro to Unsupervised Learning
K-means Clustering and Extensions, Parameter Estimation in Latent Variable Models Expectation Maximization-GMM Model Selection, Evaluation Metrics, Learning from Imbalanced Data Linear and Non-Linear Dimensionality Reduction Bias/Variance Trade-off, Some Practical Issues, Semi-supervised and Active Learning

Introduction to Artificial Neural Networks
Introduction to Deep Neural Networks, Learning to Recommend via Matrix Factorization/Completion, Reinforcement Learning

Text Book:

- Duda, Peter Hart, David Stork, “Pattern Classification”, Wiley; Second edition
- Tom Mitchell, “Machine Learning”.
- Hal Daumé III, “A Course in Machine Learning (CIML)”, 2017 .

Reference Book:

- Christopher Bishop, “Pattern recognition and machine learning”, Springer, 2007.
- Kevin Murphy, “Machine learning: a probabilistic perspective”, MIT Press, 2012.
- E. Alpaydin, “Machine Learning”,(https://www.cmpe.boun.edu.tr/~ethem/i2ml3e/)
- Kevin Murphy, “Machine Learning: A Probabilistic Perspective (MLAPP)”, MIT Press, 2012

Business Process Management (MS3601)

Objective: To introduce Business Process Modeling Notation and to analyze existing business processes to identify inefficiencies and improvement opportunities.

Course Outcomes

Students will be able to:

- Understand BPM concepts, methodologies, and lifecycle stages and learning of process identification, selection, modeling, and improvement techniques.
- Mastering process analysis and improvement strategies like Lean and Six Sigma.
- Understanding of process design and redesign strategies, Integrating IT with BPM, including WFMS and BPA tools.

Introduction

Introduction to Business Process, BPM Lifecycle, Importance of BPM in modern organizations, Process Identification, Process Selection. Introduction, concepts, properties, methodology, architecture and applications of business processes. The Different phases of Business Process Management Lifecycle.

Process Modeling

Introduction to BPMN: Will be discussed with process modelling and Business Process Modelling and Notations (BPMN). Elements of BPMN: events, activities, gateways, and flows, Branching and Merging, Creating BPMN diagrams

Process Analysis & Improvement Techniques

Techniques for analyzing business processes, Identifying inefficiencies and bottlenecks, Root cause analysis and improvement, process design and improvement: Lean, Six Sigma, Strategies for process redesign and reengineering, BPM and Architecture, Implementation Refine a BPMN model with workflow-specific activities. Real-life examples for business process modelling and innovation with group presentations.

IT and BPM

Workflow Management Systems, Implementation & Business Process Automation (BPA), Tools and technologies for BPA, Benefits and challenges of BPA

Text Books

- Business Process Change, Paul Harmon
- Business Analysis, Debra Paul; Donald Yeates & James Cadle

Reference Book

- Fundamentals of Business Process Management, Marlon Dumas, La Rosa, Marcello, Jan Mendling, Hajo A. Reijers
- Business Process Management: Concepts, Methods, Technology, Mathias Weske

Artificial Intelligence (IT3004)

Objective: To introduce the basic principles of Artificial Intelligence, problem solving, and knowledge representation

Course Outcomes

Students will be able to:

- Grasp the historical, ethical implications & basic principles of artificial intelligence
- Apply search algorithms, optimization methods, & game strategies to design intelligent problem-solving systems & decision-making and planning.
- Use probabilistic reasoning, Bayesian networks, and decision theory to address uncertainty in dynamic environments and
- Apply decision trees, ensemble methods, and reinforcement learning to learn from observations.

Introduction

Definition, History, The Turing Test, Machine Learning and Robotics, Expert Systems, Current status of AI, Weak AI, Strong AI, Ethics and Risks of Developing AI, Intelligent Agents, Agent programs, Different agents, Components, Agent Architectures

Problems Solving by Searching

Searching for Solutions, Uninformed Search Strategies, Iterative deepening, Bidirectional search, Search Strategies and Optimization, Genetic algorithms, CSP, Intelligent backtracking, minimax algorithm, Alpha-Beta Pruning, Real-Time Decisions

Knowledge Engineering

Knowledge-Based Agents, Propositional and first order logic, Knowledge Engineering, Inference, Unification and Lifting, Forward & Backward Chaining, Ontological Engineering, Planning, Planning Graphs, Logic; Acting in the Real World- Time, Schedules, and Resources, Hierarchical Task Network Planning, Conditional Planning

Uncertainty

Uncertainty, Axioms, Inference Using Full Joint Distributions; Probabilistic Reasoning, Bayesian Networks, Hidden Markov Models, Kalman Filters, Utility Theory, Decision Networks, Expert Systems, Making Complex Decisions, Inductive Learning, Learning Decision Trees, Ensemble, Statistical Learning Methods, Reinforcement Learning

Text Books

- P Norvig and S J. Russell, Artificial Intelligence: A Modern Approach, 4th ed. Pearson Education, 2022
- Deepak Khemani, First Course in Artificial Intelligence, 6th Ed., McGraw Hills,

Reference Books:

- K Knight, E Rich, S B. Nair, Artificial Intelligence, 3rd Ed., McGraw Hills, 2017
- J P Mueller, L Massaron, Artificial Intelligence For Dummies, 2nd Ed., O'Reilly,2021

Design Thinking and Innovation (IT 3501)

Objective: The objective of this course is to learn the innovation cycle of Design Thinking process for developing innovative products.

Course Outcome

Student will able to

- Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of the Design Thinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, and techniques during prototype development and to perceive individual differences and its impact on everyday decisions and further Create a better customer experience

An Insight to Learning, Remembering Memory & Emotions

Kolb's Learning Styles, Assessing and Interpreting, Understanding the Memory process, Problems in retention, Memory enhancement techniques, Understanding Emotions:

Basics of Design Thinking & Being Ingenious & Fixing Problem

Definition, Need, Objective, Concepts & Brainstorming, Stages of Design Thinking Process, Bottlenecks of Processes-Process Centric approach, Creative thinking process, Problem Solving, Testing Creative Problem Solving

Process of Product Design, Prototyping & Testing and Celebrating the Difference

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, User Interface Design, Mobile App Design, Prototype creation, Rapid Prototype Development process, Testing, Test Group Marketing, Group Discussion

Design Thinking & Customer Centricity & Feedback, Re-Design & Re-Create

Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Feedback loop, rapid prototyping & testing, final product, Creative Solution".

Text Book

Reference Book

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Data Analytics (IT3006)

Objective: The objective of this course is to make student learn about mining issues and methods/algorithms.

Course outcomes:
Students will be able to:

- Get exposure of data analysis steps
- Perform data preprocessing task
- Apply logic to implement different category of Algorithms

Introduction
Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Preprocessing the Data (Data Cleaning, Integration, Transformation & Reduction)

Mining Association Rules
Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, APRIORI, Variations of APRIORI (Sampling, Hash Based, Partitioning, Transaction Reduction), Frequent Pattern Growth, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules, Concept of LIFT, Clustering of Association rules.

Classification and Prediction
Classification by Decision Tree Induction, Bayesian Classification, Classification & Prediction continues, Classification by Back propagation, Classification Based on concepts from association Rule Mining, SVM, Regression Analysis, Classifier Accuracy.

Clustering
Data types in cluster analysis, Categories of clustering methods, partitioning methods- K-Means, PAM, CLARA, CLARANS, KNN. Hierarchical Clustering- Agglomerative and Divisive Clustering, BIRCH and Chameleon, Density Based methods-DBSCAN, CURE, OPTICS, Grid Based Methods- COBWEB

Text Book

- J. Han, M. Kamber, Jian Pei “Data Mining: Concepts and Techniques” 3rd Edition, 2011

References

- Hadzic F., Tan H. & Dillon T. S. “Mining data with Complex Structures,” Springer, 2011
- Yates, R. B. and Neto, B. R., “Modern Information Retrieval” Pearson Education, 2005

Biology for Engineers (AS1010)

Objective: The objective is to provide the fundamental knowledge of Modern Biology and its application.

Course Outcome

Students will be able to:

- Get basic understanding of the Advanced Biology
- Get exposure to different areas of Biology including Cell Biology, Microbiology, Molecular Biology, Biochemistry and Immunology.
- Learn the principles of different advanced laboratory techniques used in biological research works and interdisciplinary research.

Introduction

Introduction to living organisms, Different cell organelles and cellular processes. Prokaryotes and Eukaryotes cells.

Structures and functions

Structures and functions of bimolecules, DNA, RNA, Carbohydrates, Proteins and Lipids.

Immunity, Electrical signal & Biomaterials

Antigen, Antibody, Antigen-Antibody interactions, Electrical signal of cells, HH model. Concept of Stem cells, Differentiation, Characterization**,** Biomaterials for tissue engineering, 3D bio-printing, DNA origami and Biocomputing.

Text book

- Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Molecular Biology of the Cell.

References

- Prescott, Harley, and Klein's Microbiology by Joanne M. Willey, Linda Sherwood, and Christopher J. Woolverton.
- Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer.
- Immunology by Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby.

Process Mining & Analytics (IT 3007)

Objective: The objective is to provide the key aspects of business process analytics and a solid foundation for studies in the Process mining field.

Course Outcome
Students will be able to:

- Have a good understanding of the basic concepts of Process Mining.
- Understand the role of Data Science in Today's Life.
- Have a good understanding of the data needed to start a process mining project.

Process Analytics
Analytics as a combination of Process Modeling and Process Mining, Characteristics and challenges of standard business processes, Process modeling notations: BPMN, Petri Nets, and modeling tools, Types of business processes: Order-to-Cash (O2C), Procure-to-Pay (P2P), Hire-to-Retire (H2R), Quote-to-Order (Q2O), Sample event logs for different processes and their significance, Benefits of process mining and actionable insights from event data analysis.

Business Process types and Organizational structures
Introduction to Event Log Data & Traces and their attributes, Using various Process Mining Tools for Event Data processing, Process mining tools for event data processing (PM4Py, ProM, Celonis, Disco), Petri net analysis in process mining.

Basic process discovery, process discovery algorithms
Process discovery algorithms: Alpha Miner, Heuristic Miner, Inductive Miner, and Genetic Miner, Software tools for process discovery, Quality dimensions, Conformance checking and Process enhancement, Process model matching and similarity. Concept of conformance checking in process mining, Importance of aligning event logs with process models, conformance analysis, Methods, Token-based replay, Alignment-based conformance checking, Fitness, precision, generalization, and simplicity metrics.

OCPM (Object Centric Process Mining)
Multi-Entity Event Logs, Object-Centric Event Data Model, Object-Centric Petri Nets (OCPN), Discovery of OCPM, Quality metrics for OCPM, AI applications in process mining using a Large language model, Explainable AI in Process mining

Text book

- Basics of Business Informatics by Peter Weber, Roland Gabriel • Thomas Lux • Katharina Menke Springer-Vieweg, Berlin, 2021
- Information Systems: A manager's Guide to Harnessing Technology (Version 9.0) by John Gallaugher -FlatWorld

References

- MIS-Managing the Digital Firm (13th Edition) by Kenneth C Laudon. Jane P. Laudon.(Pearson)

French Language (MS 1502)

Objective: To equip students with the necessary skills to understand, speak, read, and write French effectively, allowing them to communicate in everyday situations, including basic grammar, vocabulary, pronunciation, and cultural understanding, often aiming to reach a specific proficiency level.

Course outcome
At the end of this course, Students will

- be familiar with the pronunciation of French letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction
Personal Information, Introducing yourself (name, age, nationality), Family members Basic greetings and farewells

Basic Communication
Asking and answering simple questions, Expressing likes and dislikes, Making requests.

Numbers and Time
Counting, Telling time, Days of the week and months

Everyday Life
Describing daily routines, Talking about hobbies and interests, Weather descriptions

Places and Directions
Asking for and giving directions, Identifying basic places in a town

Shopping and Dining
Making simple purchases, Ordering food and drinks

Basic Grammar
Subject-verb agreement, Present tense verb conjugation, Basic sentence structure, Articles (le, la, les, un, une)

German Language (MS 1500)

Objective: The student will learn the basics of standard German language, and will get to know about the norms of language of German.

Course outcome
At the end of this course, Students will

- Be familiar with the pronunciation of German letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction
Alphabets, Numbers, Greetings

Phrases
Basic introductory phrases

Calenders
Days of the week, Months

Introduction of self and introduction of others
Map, Time, Vocabulary- things around, Nations and nationalities, stationery, professions, hobbies

Grammar
present tense, past tense, plurals, pronouns, verb conjugations, (regular, and three or four important irregular verbs), prepositions, and so on

Japanese Language (MS 1501)

Objective: The student will learn the basics of standard Japanease language, and will get to know about the norms of language of Japan.

Course outcome

At the end of this course, Students will

- Be familiar with the pronunciation of Japan letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Introduction to Japanese Syllables (phonetic alphabet), greetings & Self introduction, Identifying things, point objects and listen to their names, Listen to things and places etc. Creating shopping lists

Time Delay

Introduction to Time, day of the week, simple inquiries on telephone, Means of transport, Basic conversations of everyday life.

Frame questions in Japanese

Vocabulary of giving and receiving objects. Stating impressions/things surrounding us, Expressing likes and dislikes, good/bad, possessions. Talking about the country, town and the environment.

Quantity

Number of people, time, period etc., Stating thoughts and impressions. Conveying movement (e.g. go / come)

Sanskrit Language (MS 1401)

Objective: The student will learn the basics of standard Sanskrit language, and will get to know its importance with respect to national unity, integrity, morality and spirituality.

Course outcome

At the end of this course, Students will be

- familiar with the pronunciation of Sanskrit language
- understand ancient scientific concepts, principles, and methodologies without the limitations of translations or interpretations

Introduction to Sanskrit Phonetics

Devanagiri Lipi: Swar and Vyanjan. (Writing rules,Definition,classification,Pronunciation system),Sanskrit Sentence formationand spoken Sanskrit rules.Translation:From Sanskrit to English or English to Sanskrit. Sanskrit Subhashita.

Sanskrit grammar

Sandhi (introduction, classification, Swar-Sandhi),Kāraka&Vibhakti (Definition, Types, Example). Sabdārūpa&Dhāturūpa.

Introductory Vedic & Classical Literature

Four Vedas, Āraṇyakas, Upaniṣads, Vedāṅgas, Purāṇas.Rāmāyaṇa(by Vālmīki) and **Mahābhārata** (by Vyāsa), Bhagavad Gita etc.

Introductory Vedic Mathematics and Sciences in Sanskrit:

Illustrations from book- Vedic Mathematics written by Bharati Krishna Teertha ji, (published by MLBD) –Calculation pi, square root finding, Philosophical meanings of zero and one. Surya Siddhanta. (Kalganana), Katapayadi Sankhya,NāradāŚilpa Śāstra(Architecture and Vastu Shastra), Aṣṭāṅga Hridayam.

Modern Age Possibilities: Sanskrit for ICT : Paper by Subhash Kak and Saroja Bhate Panini's Grammar and Computer Science.

Text Books:

- Sanskrit Sahitya ka Samikshatmak Itihas by Dr. Kapil Dev Dwivedi.

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ELECTIVES

(Some of the elective's syllabus are as follows)

Visual Recognition (IT5525)

Objective: To introduce the basic principles of visual recognition, CNN, Generative and Large-Language Models.

Course Outcomes

Students will be able to:

- Apply the concepts to solve some real problems in recognition.
- Use computational visual recognition for problems ranging from extracting features, classifying images, to detecting and outlining objects and activities in an image or video.
- Use ML and deep learning concepts to solve the visual recognition problems and to invent new methods in visual recognition for various applications.

Introduction

Visual Recognition Introduction, Overview and Historical Context, Image Features, Feature Detection, Properties of Features, Feature Representation, Regional Descriptors-SIFT and Local Descriptors-LBP. Data-driven Approaches, Neural Networks.

Convolutional Neural Networks: CNN Architectures for Image Recognition, Residual Concept, Object Detection, Semantic Segmentation, and Dense Prediction.

Generative and Large-Language Models: Adversarial Attack and Defense, Image Generation, Variational Auto-encoders, Generative Adversarial Networks, Recurrent Neural Network, Image Captioning, Visual Question Answering, Attention Mechanism, Self-Attention, Transformer Models.

Recent Research Trends: Biometrics: Video Recognition, Video Analytics: Scene Understanding, Action Recognition, Crowd Behavior Analysis, Surveillance Systems; Super-resolution, Image-to-Image Translation, etc.

Text Books

- “Computer Vision: Algorithms and Applications”, Richard Szeliski, Second Edition, 2022, Springer.
- “Deep Learning”, Ian Goodfellow, Aaron Courville, and Yoshua Bengio, First Edition, 2016, The MIT Press.

Reference Books

- “Computer Vision: A Modern Approach”, Forsyth and Ponce, Second Edition, 2015, Pearson Education India.

Deep Learning (IT5505)

Objective: To introduce the basic principles of different deep architectures, mathematics involved in deep learning solutions and to develop deep learning solutions.

Course Outcomes

Students will be able to:

- Acquire knowledge of different deep architectures for different data modalities.
- Be exposed to the background mathematics involved in deep learning solutions, and categorize deep architecture to use for solving problem in deep learning.
- Set up the hyperparameters and train the deep learning models and validate the trained models.
- Develop deep learning solutions for real-world problems.

Neural Networks

Machine learning challenges motivating deep learning. Basic concepts of perceptron. Overfitting and underfitting, bias and variance, Fundamentals back propagation algorithm, Gradient based optimization. Deep Neural Network.

Convolutional Neural Networks

Convolutional Neural Networks (CNN), Training Aspects of Neural Networks, Activation Functions, Gradient Descent Optimizers, Weight Initialization, Regularization, Dropout, Batch Normalization, Data Augmentation, Transfer Learning, etc.

CNN Architectures

State-of-the-art CNN Architectures and Applications. Self-supervised Learning, Deep Network Visualization, Generative Adversarial Networks (GAN) and variants

Recurrent Neural Networks

Recurrent Neural Networks (RNN), RNN Variants, Attention Model, Deep Reinforcement Learning, and Trends in Deep Learning.

Text Books

- “Deep Learning”, Ian Goodfellow, Aaron Courville, and Yoshua Bengio, First Edition, 2016, The MIT Press.

Reference Books

- “Neural Networks and Deep Learning: A Textbook:, Charu C. Aggarwal, First Edition, 2018, Springer
- “Deep Learning with Python”, François Chollet, First Edition, 2017, Manning Publications.
- “Neural Networks and Deep Learning”, Michael Nielsen, First Edition, 2015, Determination Press.
- “Learning Deep Architectures for AI”, Yoshua Bengio, First Edition, 2009, Now Publishers.

Computer Vision (IT5526)

Objective: To introduce the basic principles of computer vision, image enhancement, filtering, and segmentation.

Course Outcomes

Students will be able to:

- Understand the fundamental concepts and principles of computer vision and apply image processing techniques for tasks such as image enhancement, filtering, and segmentation and Implement feature extraction methods.
- Utilize machine learning algorithms for classification in computer vision.
- Develop new state-of-the-art computer vision methods.

Introduction

Human Vision & Computer Vision, Eye & Brain, Low, Intermediate & High level Vision, Visual Perception, Processing, Illusions, Structuralism, Gestaltism, Ecological Optics, Marr's 2.5 D Sketch, Color Perception & Processing, neuromorphic computing.

Viewing through Camera

Multiview Geometry Camera, Image and World Reference Frames, Camera Calibration. Perspective, and Epipolar Geometry, Binocular Stereopsis, Homography, Rectification, DLT, RANSAC, Depth Map and 3D reconstruction, Depth Estimation stitching.

Shape, Surface and Shading, Filtering, Feature Detection and Matching

Brain Inspired High level vision computing, Simulation of Visual Attention and Visual Memory Processes. Shape from X and Motion Analysis Light at Surfaces, Phong Model, Reflectance Map, Albedo estimation, Photometric Stereo, Use of Surface Smoothness Constraint, Shape from Texture, color, motion and edges. Image Filtering, Feature level Processing, Hough transform, Harris corner detector, Image pyramid, Scale Invariant Feature Transform, Surfaces Extraction; Principal Component Analysis and Eigenfaces

Image Segmentation & Motion Models, Convolutional Neural Networks

Expectation-Maximization algorithm, active contour model, Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo, Motion parameter estimation; Motion Models and Analysis; Rigid and Non–Rigid Body Motion, Basics, Projects on applying computer vision algorithms to the real-world problem.

Text Books

- Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2nd edition, 2012.
- Computer Vision: Algorithms and Applications, Richard Szeliski, Springer, 2nd edition, 2022.

Reference Books

- Handbook of Computer Vision and Applications, Vol.1, Vol.2, Vol.3, by Bernd Jahne, Horst Haubecker, and Peter Geibler (Eds.), Academic Press, London, 1999.

Parallel and Distributed Computing (IT5518)

Objective: To introduce the basic principles of various parallel and distributed computing platforms

Course Outcome

Students will be able to:

- Understand the basics of various parallel and distributed computing platforms.
- Identify the models and frameworks best suited to various workloads.
- Apply parallel and distributed computing techniques to solve real world problems
- Develop critical analytical skills to evaluate and analyze the performance of parallel and distributed programs.

Introduction to PDC

Latency vs Bandwidth, Applications and Challenges, Types of architecture, Flynn's taxonomy, Basic concepts: cores, nodes, threads, processes, speedup, efficiency, overhead, strong and weak scaling (Amdahl's law, Gustafson's law), Cache, Principle of Locality, Programming Models

Parallel Computing

Shared memory, data & task parallelism, Synchronization, Concurrent Data Structures, Shared Memory Programming with available APIs: PThreads, OpenMP, TBB

GPU Programming

GPU Architecture, Programming Models: CUDA/OpenCL, Basic Concepts: Threads, Blocks, Grids, GPU memory hierarchy, Thread Scheduling, Warps and Control divergence, Memory Coalescing, Programming with CUDA, Using: CuBLAS, CuFFT.

Distributed Computing

Distributed Memory, Message Passing Interface, Asynchronous/Synchronous computation/communication, concurrency control, fault tolerance, Distributed Programming with Open MPI

Textbooks:

- "Introduction to Parallel Computing", Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Addison-Wesley, Second Edition.
- "Programming Massively Parallel Processors: A Hands-on Approach", Wen-Mei W Hwu, David B Kirk, Morgann Kaufmann, Third edition.

References:

- "The Art of Multiprocessor Programming", Maurice Herlihy and Nir Shavit, Morgan Kaufmann Publishers.
- "Principles of Parallel Programming", Calvin Lin and Larry Snyder, Addison-Wesley.
- "Introduction to Parallel Programming", Peter S. Pacheo, Morgan Kaufmann Publishers.

Natural Language Processing (IT5527)

Objective: To introduce the fundamental concepts of NLP and deep learning

Course Outcomes

Students will be able to:

- Understand the fundamental concepts of NLP and deep learning.
- Implement basic NLP preprocessing tasks and deep learning models.
- Analyze the performance and effectiveness of various NLP models.
- Evaluate ethical considerations and potential biases in NLP applications and design and develop custom NLP solutions using advanced DL techniques.

Overview of NLP, Data Cleaning and Preparation

Basic Linguistic Concepts; Linguistic structures; Core NLP Tasks; NLP Tools and Libraries; Ethical Considerations; OpenAI, Hugging Face, ChatGPT, Text Normalization and Standardization, Tokenization, Stemming and Lemmatization, Regular Expressions, Text Vectorization; Data Preparation: One-Hot Encoding, BoW, Term Frequency-Inverse Document Frequency, Word Embeddings, Word2Vec, GloVe, FastText

Deep Learning for NLP

Word Embeddings: Word2Vec, GloVe, FastText, Contextual embeddings: ELMo, BERT; CNN- Applying CNNs to text data, RNN, LSTM, GRUs; text classification and sentiment analysis; Encoder-decoder architecture, machine translation and text summarization; Introduction to attention, Self-attention; Transformers, BERT, GPT; Pre-trained models and fine-tuning; Evaluation Metrics: Accuracy, precision, recall, F1-score, BLEU, METEOR, ROUGE, CIDEr

NLP Applications: Text classification using ML/DL; Image Caption Generation; Pre-trained CNN models to extract image features; combining CNNs and RNNs; Attention mechanisms to improve caption quality; transformers for image captioning; text Generation techniques.

Text Books

- “Deep Learning for Natural Language Processing”, Stephan Raaijmakers, First edition, 2022, Manning Publications.
- “Natural Language Processing with Python”, Steven Bird, Ewan Klein, and Edward Loper; First Edition, 2011, O'Reilly Publications
- “Natural Language Processing in Action”, Hobson Lane, Hannes Hapke, and Cole Howard, First Edition, 2019, Manning Publications

Reference Books:

- “Transformers for Natural Language Processing” Denis Rothman, First Edition, 2021, Packt Publishing
- “Applied Natural Language Processing with Python” Taweh Beysolow II, First edition, 2018, Apress
- “Natural Language Processing with Transformers”, Revised Edition, Lewis Tunstall, Leandro von Werra, Thomas Wolf, 2022, O'Reilly

Database Security (IT5528)

Objective: To introduce the security issues in the local and remote database

Course Outcomes

Students will be able to:

- Understand the security issues in the local and remote database and Learn different security techniques to secure the database against various attacks.
- Understand the overhead of the security techniques and the need for an efficient security mechanism.
- Learn the method to create the data ownership proof.
- Understand the applicability of the database security in real life applications.

Introduction to Database

Relational Database & Management System, ACID Properties, Normalization, RAID, Relational Algebra, Query tree, Data Abstraction - Physical Level, Logical Level & View Level, Multi-level Database, Distributed Database

Security issues in Database

Possible Attacks, Polyinstantiation - Integrity Lock - Sensitivity Lock – Security Models – Access Control (Grant & Revoke Privileges) - Statistical Database, Differential Privacy. Distributed Database Security. Outsourced Database and security requirements – Query Authentication Dimension – Condensed RSA, Merkle Tree, B-$^{+}$ Tree with Integrity and Embedded Merkle B-Tree –

Partitioning & Mapping

Keyword Search on Encrypted Data - Text file. Geospatial Database Security – Geospatial data models – Geospatial Authorization, Access Control Models: Geo-RBAC, Geo- LBAC. Privacy-Preserving Data Mining – Introduction - Randomization method: Privacy Quantification, Attacks on Randomization, Multiplicative Perturbations, Data Swapping - *K*-Anonymity framework, L-Diversity, t-closeness, Distributed Privacy-Preserving Data Mining.

Database Watermarking

Basic Watermarking Process - Discrete Data, Multimedia, and Relational Data – Attacks on Watermarking - Single Bit Watermarking, Multi bit Watermarking.

Reference Books

- Michael Gertz and Sushil Jajodia (Editors), Handbook of Database Security: Applications and Trends, ISBN-10: 0387485325. Springer, 2007
- Osama S. Faragallah, El-Sayed M. El-Rabaie, Fathi E. Abd El-Samie, Ahmed I. Sallam, and Hala S. El-Sayed, Multilevel Security for Relational Databases by; ISBN 978-1-4822-0539-8. CRC Press, 2014.
- Bhavani Thuraisingham, Database and Applications Security: Integrating Information Security and Data Management, CRC Press, Taylor & Francis Group, 2005.

Blockchain Technology (IT 5529)

Objective: To introduce the need and working of block chain technology, its variants and implementation.

Course Outcomes

Students will be able to:

- Understand the need and working of blockchain technology and its variants.
- Understand the basic components of the implementation of the blockchain technology and the implementation in cryptocurrency and various attacks.
- Learn to implement blockchain technology in various non cryptocurrency applications and to develop a blockchain based real time application.

Basics

Distributed Database, Two General Problem, Byzantine General problem and Fault Tolerance, Hadoop Distributed File System, Distributed Hash Table, ASIC resistance, Turing Complete. Cryptography: Hash function, Digital Signature - ECDSA, Memory Hard Algorithm, Zero Knowledge Proof.

Blockchain

Introduction, Advantage over conventional distributed database, Blockchain Network, Mining Mechanism, Distributed Consensus, Merkle Patricia Tree, Gas Limit, Transactions and Fee, Anonymity, Reward, Chain Policy, Life of Blockchain application, Soft & Hard Fork, Private and Public blockchain. Sybil Attack, Distributed Consensus: Nakamoto consensus, Proof of Work, Proof of Stake, Proof of Burn, Difficulty Level.

Cryptocurrency

Distributed Ledger, Bitcoin protocols - Mining strategy and rewards, Ethereum - Construction, DAO, Smart Contract, GHOST, Vulnerability, Attacks, Sidechain, Namecoin, Cryptocurrency Regulation: Stakeholders, Roots of Bitcoin, Legal Aspects - Cryptocurrency Exchange, Black Market and Global Economy, Attacks - Layer 2 Blockchain Attacks, Stateless Blockchain, Hyperledger Fabric and IOTA, Anonymous Blockchain -Monero, Blockchain Applications: Internet of Things, Medical Record Management System, Domain Name Service and Web 3.0.

Text Book

- Arvind Narayanan, Joseph Bonneau, Edward Felten, Andrew Miller and Steven Goldfeder, Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction, Princeton University Press (July 19, 2016).
- Venkatesan Subramanian, Sandeep Kumar Shukla and Mohan Dawan, Blockchain and Cryptocurrency [Book Draft]

References:

- Wattenhofer, The Science of the Blockchain,2016
- Antonopoulos, Mastering Bitcoin: Unlocking Digital Cryptocurrencies, 1st Edition, 2015
- Satoshi Nakamoto, Bitcoin: A Peer-to-Peer Electronic Cash System

Remote Sensing and GIS (IT5530)

Objective: To introduce the concept of Remote Sensing and GIS principles

Course Outcomes

Students will be able to:

- Understand Remote Sensing and GIS principles.
- Work on Remote Sensing and GIS Data for various applications.

Remote Sensing Principles

Scope of remote sensing, Remote sensing imagery, Energy sources and radiation principles, Electromagnetic radiation and its interaction with the surfaces and atmosphere, Land observation satellites, Active and Passive Remote sensing

Image Acquisition

Fundamentals of image acquisition, Digital photographic sensor systems, The role and importance of digital data, Ground truth, Image interpretation, Various Earth observation missions, Microwave, LiDAR, Thermal sensor systems, The role of image resolution in projects integrating remote sensing and GIS

Image Analysis

Image preprocessing (i.e. radiometric, geometric corrections, and feature extraction), Pattern recognition, Shape analysis, Textural analysis, Digital image classification, Accuracy assessment, Hyperspectral remote sensing

Geographic Information System and Remote Sensing Applications

Information system, Components of GIS, Geospatial data architecture, Geographic co-ordinate systems, Map projections, GIS categories, GIS data types, Data Representation, Data sources, GIS software, Land use/land cover analysis, Geologic, geomorphic, soil and hydrologic phenomena at a variety of scales

Text Book

- Thomas M. Lillesand, Ralph W. Kiefer, Jonathan W. Chipman, Remote Sensing and Image Interpretation, 7th Ed. John Wiley & Sons, 2015
- Kang tsung Chang, Introduction to Geographical Information System, 9th Ed. Tata McGraw Hill, 2020.

References:

- George Joseph, C. Jeganathan, Fundamentals of Remote Sensing, 3rd Ed. Universities Press, Hyderabad 2018
- A.M. Chandra and S.K. Ghosh. Remote Sensing and Geographical Information system, 2nd Ed. Alpha Science International Ltd. 2015

Big Data Analytics (IT5517)

Objective: To introduce the concept of big data analytics and its application

Course Outcomes
Students will be able to:

- Perform a detailed study of big data analytics.
- Apply big data analytics in practical problems.

Introduction to Big Data and its importance
3 Vs and more, Big data analytics, Big data applications. Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop, Inputs and outputs of MapReduce, Hadoop Architecture, HDFS, Common Hadoop Shell commands, NameNode, Secondary NameNode, and DataNode

Maps
Hadoop Map Reduce paradigm, Map and Reduce tasks, Job, Task trackers , Algorithms using MapReduce, Examples of Map Reduce (Word count problem, Matrix-Vector vector multiplication), YARN & Zookeeper, Hadoop Cluster Setup & Hadoop Configuration, and HDFS Administration: Monitoring & Maintenance

Hive Architecture, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase Concepts; Advanced Usage, Schema Design & Indexing - PIG, Zookeeper

Spark
RDD in Spark, Data Frames & Spark SQL, Spark Streaming, MongoDB, NoSQL

Text Book

- Chris Eaton, Dirk Deroos et al. , “Understanding Big data ”, McGraw Hill, 2012
- Boris Lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions," Wiley, ISBN: 9788126551071, 2015

References:

- Tom White, “HADOOP: The Definitive Guide”, O'Reilly 2012
- Aven Jeffrey, Data Analytics with Spark Using Python | Big Data | First Edition | Pearson Paperback, November 2018

Social Network Analysis (IT5531)

Objective: To introduce the concept of social network analysis and its significance

Course Outcomes

Students will be able to:

- Understand the concept of social network analysis and its significance.
- Identify different types of networks, their characteristics, and fundamental concepts in analysing the large-scale data that are derived from social networks
- Implement mining algorithms for social networks and perform hands-on lab exercises to implement network analysis techniques
- Apply network analysis methods to solve practical problems in various domains, including social media, healthcare, e-commerce, and scientific research.
- Collaborate with peers and communicate findings effectively through lab reports and presentations.Introduction, representation, visualisation, centrality and power, strength of the weak ties, diffusion, homophily. Gephi and other tools

Introduction

Introduction to Social Network Analysis, Graph Models and Node Metrics

Social-Network Graph Representation

Social-Network Graph Representation-Analysis and Properties, Community Structure, Link Analysis and Prediction, Information Diffusion in Social Networks

Dynamic Social Networks

Dynamic Social Networks, Applications, Case studies and Research Trends

References:

- Networks, Crowds and Markets by David Easley and Jon Kleinberg, Cambridge University Press, 2010
- Network Science, Albert-Lazzlo Barabasi
- Social and Economic Networks by Matthew O. Jackson, Princeton University Press, 2010.
- Social Network Analysis, Tanmoy Chakraborty, Wiley, 2021
- Social Network Analysis: Methods and Applications, Stanley Wasserman, Katherine Faus
- https://networkx.org/documentation/stable/reference/

Generative AI and LLMs (IT5532)

Objective: To introduce the concept of Generative AI and LLMs

Course Outcomes
Students will be able to:

- Understand the concept of Generative AI, Deep Learning Fundamentals
- Understand the concept of Natural Language Processing, Language Models, Basics of GANs and Learn advanced topics in Large Language Models

Introduction to Generative AI
Overview of Generative Models, Definition, types, Applications. Probability and Statistics Foundations, Probability distributions MLE and Bayesian inference, Introduction to Neural Networks, Basics of feedforward and recurrent neural networks

Deep Learning Fundamentals & Natural Language Processing
Backpropagation & gradient descent functions, Training, Overfitting, regularization, and dropout Hyperparameter tuning, NLP, Tokenization, stemming, and lemmatization Part-of-speech tagging, Word Embeddings Word2Vec, GloVe, and embeddings

Introduction to Language Models & Sequence-to-Sequence Models
N-grams to neural language models, Challenges, RNNs for Sequences Understanding sequential data Challenges of vanishing and exploding gradients, Seq2Seq Models Encoder-decoder architecture Attention mechanisms, Applications of Seq2Seq Models Machine Translation, summarization etc

Generative Adversarial Networks, Transformers & Advanced Topics in LLM
GANs, Generative vs. discriminative models GAN architecture and training process, Applications of GANs, Transformer Architecture, BERT and Pre-trained Models Bidirectional Encoder Representations from Transformers Fine-tuning for various tasks, Llama -2 model Architecture and Training Overview of GPT, Challenges and issues of Training LLM, Applications

Ethical Considerations in AI & Future Trends and Research Directions
Bias and Fairness Addressing biases in AI models Ensuring fairness in language models 9.2 Social Implications and Responsible AI Impact of AI on society Ethical considerations in AI research and development, Current Research Trends - State-of-the-art models and techniques - Open challenges and future directions 10.2 Student Projects and Presentations - Hands-on projects using popular frameworks (e.g., TensorFlow, PyTorch) - Final project presentations and discussions

Text Book:
References:

Large Language Model Conditioned Human-Robot Interactions (IT5533)

Objective: To introduce the concept of Large Language Model Conditioned Human-Robot Interactions

Course Outcomes
Students will be able to:

- Gain insights into the integration of advanced language models into robotic systems, allowing for more sophisticated and context-aware interactions

Introduction to Large Language Models and Robotics
Overview of large language models (e.g., Llama2,GPT-3, BERT) Introduction to human-robot interactions Challenges and opportunities in integrating LM with robots

Natural Language Processing for Human-Robot Interactions
Fundamentals of natural language processing (NLP) Syntax and semantics in robot communication Sentiment analysis and emotion recognition

Machine Learning for Language Understanding
Supervised and unsupervised learning approaches Training language models for specific tasks Transfer learning and fine-tuning techniques

Implementing Large Language Models in Robotics
Integrating language models into robot systems Design principles for large language model-conditioned robots Hands-on programming exercises and projects

Ethical Considerations and Social Implications
Ethical frameworks in AI and robotics Bias and fairness in language models Impact of large language model-conditioned robots on society

Text Book:

- "Natural Language Processing in Action" by Lane, Howard
- Hapke "Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow" by Aurélien Géron

References:

Distributed Systems (IT5534)

Objective: To design and develop distributed programs and analyze different algorithms and techniques for the design and development of distributed systems

Course Outcomes

Students will be able to:

- Design and develop distributed programs using sockets and RPC/RMI.
- Analyze different algorithms and techniques for the design and development of distributed systems
- Identify the advantages/disadvantages and challenges in designing distributed algorithms for different primitives like mutual exclusion, deadlock detection, agreement, etc.
- Differentiate between different types of faults and fault handling techniques in order to implement fault tolerant systems.

Introduction

Defining Distributed Systems, Goals and Challenges, Representation, Models of Distributed Systems, Architecture Models of computation, Client-Server architecture - Application layering; Peer to Peer Systems;

Middleware & Distributed Computing Model

Message passing systems, synchronous and asynchronous systems; Remote procedure calls, Remote Method Invocation, Clock and Causal Ordering: Managing physical clocks in distributed systems; Logical clocks: Lamport's and vector clocks;
Global state recording and Snapshot Algorithms; Clock synchronization,

OS concepts

Distributed mutual exclusion - permission based algorithms, token based algorithms. OS concepts, Handling deadlocks; Event driven systems for asynchronous Distributed Systems; Distributed Leader election Algorithms; Distributed Termination Detection Algorithms; Distributed Consensus and agreement

Resource management

Distributed file systems; DFS examples: Hadoop; Load distribution; Cloud computing, SOA; Fault tolerance and recovery; Distributed & Routing Algorithms, Graph traversals;

Text Book:

- A.D. Kshemkalyani, M. Singhal, Distributed Computing: Principles, Algorithms, and Systems.
- George Coulouris Jean Dollimore, and Tim Kindberg, Distributed Systems: Concepts and Design.

References:

- Nancy Lynch; Distributed Algorithms/ Sukumar Ghosh, Distributed Systems.
- Andrew S. Tanenbaum and Martan Van Steen, Distributed Systems, Principles and Paradigms.

Optimization (IT5535)

Objective: To recognize and formulate convex optimization problems.

Course Outcomes

Students will be able to:

- Recognize and formulate convex optimization problems as they arise in practice
- Know a range of algorithms for solving linear, quadratic and semi definite programming problems, and evaluate their performance
- Understand the theoretical foundations and be able to use it to characterize optimal solutions to optimization problems in Machine Learning

Convex Analysis

Convex Sets, Convex Functions, Calculus of convex functions

Optimality of Convex Programs

1st order nec. and suff. conditions, KKT conditions, Duality: Lagrange and Conic duality

Standard Convex Programs and Applications

Linear and Quadratic Programs, Conic Programs: QCQPs, SOCPs, SDPs.

Optimization Techniques

Smooth Problems: Gradient descent, Stochastic gradient descent, Newton's methods, Interior Point method. Nonsmooth Problems: Subgradient descent, Online convex optimization, Non-convex optimization: Adom and other variants.

Text Book:

- S.Boyd and L.Vandenberghe. Convex Optimization. Cambridge University Press, 2004

References

- R.T.Rockafellar. Convex Analysis. Princeton University Press, 1996.
- A.Nemirovski. Lectures On Modern Convex Optimization (2005). Available at
- www2.isye.gatech.edu/~nemirovs/Lect_ModConvOpt.pdf
- Y.Nesterov. Introductory Lectures on Convex Optimization: A Basic Course. Kluwer Academic Publishers, 2004

Probabilistic Graphical Models (IT 5536)

Objective: To understand about probabilistic machine learning and describe and analyze properties of graphical models, and formulate suitable models.

Course Outcomes
Students will be able to:

- Understand about probabilistic machine learning and get exposure to current cutting edge research.
- To develop an in-depth understanding of probabilistic graphical models.
- To describe and analyze properties of graphical models, and formulate suitable models for concrete estimation and learning tasks.
- To understand inference algorithms, judge their suitability and apply them to graphical models in relevant applications.

Probabilistic supervised learning

Probabilistic Unsupervised learning

Graphical Model representation
Bayesian and Markov networks, and dynamic Bayesian networks. Probabilistic inference algorithms, both exact and approximate; Sampling; and learning methods for both the parameters and the structure of graphical models. Encoder-Decoder, Variational Autoencoder, Generative Adversarial Network (GAN)

Text Book

- Kevin Murphy, “Machine learning: a probabilistic perspective”, MIT Press, 2012.

References:

- Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques
- Michael I. Jordan, An Introduction to Probabilistic Graphical Models, in preparation.

Cyber Security and Digital Forensics (IT 5537)

Objective: To understand Cyber Crime Classification and its mapping with IT Act

Course Outcomes
Students will be able to:

- Understand Cyber Crime Classification and its mapping with IT Act.
- Understand the importance of digital investigation lifecycle and attack classification.
- Understanding how to handle digital evidence and its classification in different scenarios like system forensics, network forensics and other domains.
- Understand the analysis of E- evidence and correlation with class of cyber crime.

Introduction to Cyber Crime and E-Evidence
Cyber Crime Classification based on behavioral features, Relevant section of IT Act implicating the E-Evidence. Digital Forensics Life Cycle.

System Forensics & Handling E-Evidence
Registries and file systems e.g NTFS. Data acquisition, verification, errors in handling data, Registry analysis.

Network Forensics
Network Forensics, analysis of the network traffic, flow and protocol analysis, network based attacks, specialized tools, OSINT Framework, analysis of TCPDUMP file and experimentation for data acquisition.

Incident handling and Report writing
Admissibility of E-evidence, Verification of the integrity of evidence, Types of Evidence, Test of Admissibility of Evidence

Text Books

- John R. Vacca, “Computer Forensics: Computer Crime Scene Investigation”, Cengage Learning, 2nd Edition, 2005
- Marjie T Britz, “Computer Forensics and Cyber Crime: An Introduction”, Pearson Education, 2nd Edition, 2008.

References:

- MariE-Helen Maras, “Computer Forensics: Cybercriminals, Laws, and Evidence”, Jones & Bartlett Learning; 2nd Edition, 2014.
- Chad Steel, “Windows Forensics”, Wiley, 1st Edition, 2006.
- Majid Yar, “Cybercrime and Society”, SAGE Publications Ltd, Hardcover, 2nd Edition, 2013.
- Robert M Slade, “Software Forensics: Collecting Evidence from the Scene of a Digital Crime”, Tata McGraw Hill, Paperback, 1st Edition, 2004.

B.TECH- ECE

Applicable with effect from 2023 admitted batch and onwards

Engineering Physics (AS1001)

Objective: Students will be able Demonstrate ability to collect, process, and analyze scientific data, display critical thinking skills in applying physics knowledge in the experimental process.

Course outcome

At the end of this course, Students will be able to

- To analyze dynamics of system of particles for applications in Physics and Engg.
- Identify, formulate and solve engineering problems requiring principles of physics
- Gain knowledge about modern physics and quantum mechanics
- Apply quantum physics to understand solid state materials
- Design & conduct experiments, analyze & interpret data

Classical Mechanics

Symmetry and conservation laws, Fermat's principle, Principle of least action, Euler Lagrange equations and its applications, Degrees of freedom, Constraints and constraint forces, Generalized momentum, Concept of phase space, Hamiltonian.

Quantum Mechanics

De Broglie's hypothesis, wave function and wave packets, phase and group velocities. Schrödinger Equation. Probabilities and Normalization, Eigenvalues and eigen functions. Infinite potential well and energy quantization. Finite square well, potential steps and barriers - notion of tunneling, band structure of solid.

Solid State Physics

Energy Bands, Carrier transport in semiconductor, mobility and resistivity, electron effective mass, Density of states, Fermi-Dirac distribution function, intrinsic carrier concentration, Mechanism of carrier scattering, Einstein relationship.

Text Books

- Classical Mechanics; H. Goldstein, C. Poole, J. Safko; Pearson Education, Third Edition (2002)
- Modern Physics by A. Beiser; McGraw-Hill Higher Education, Sixth Edition (2003)
- Introduction to Quantum Mechanics by D. J. Griffiths; Pearson Education, Second Edition (2005)
- Introduction to Solid State Physics by C. Kittel; Wiley Students Edition, (2005)
- Physics of semiconductor devices, S M Sze, John Wiley & Sons, 2006

Reference Books

- Theoretical Mechanics by M. Spiegel; McGraw Hill Education, 2017
- Feynman Lectures of Physics Vol-1 and Vol-3; The Millenium Edition, Pearson (2012)
- Quantum Physics for Atoms, Molecules, Solids, Nuclei and Particles by R. Eisberg and R. Resnick; 2nd Edition, New Delhi Wiley (2012)

Linear Algebra (AS1002)

Objective: Students will be able to solve linear equations & develop understanding of vector spaces, linear transformations, Eigen value, diagonalization and orthogonalization, least square solutions and singular value decomposition etc

Course Outcome

Students will be able to

- Understand the concept of matrices, their properties & solve linear equations
- Understand basic concepts of vector spaces, subspace, linear dependence etc
- Calculate the rank-nullity of a matrix / linear map, eigenvalues, and eigenvectors.
- Apply the Gram-Schmidt process, Find the SVD, Jordan Canonical form .
- Apply concepts of linear algebra to various applications.

Matrices and Vector Spaces

System of linear equation, Gauss elimination method, Elementary matrices, Invertible matrices, Gauss-Jordan method, Determinant, Cramer's rule, Vector spaces, Linearly independence and independence, Basis, Dimension.

Linear transformation & Diagonalizability

Linear transformation, Representation of linear maps by matrices, Rank-Nullity theorem, Rank of a matrix, Row and column spaces, Solution space of a system of homogeneous and non-homogeneous equations, Eigenvalue, eigenvector, Cayley-Hamilton theorem, Diagonalizability, minimal polynomial

Inner product space

Inner product space, Cauchy-Schwarz inequality, Orthogonal basis, Gram-Schmidt orthogonalization process, Orthogonal projection, Spectral theorem.

SVD & Jordan Canonical Form

Positive, negative, and semi-definite matrices. Decomposition of the matrix in terms of projections, Strategy for choosing the basis for the four fundamental subspaces, Least square solutions and fittings, Singular values, Primary decomposition theorem, and Jordan canonical form.

Text/Reference Books

- K. Hoffman and R. Kunze, Linear Algebra, 2nd Edition, Pearson (2015).
- Gilbert Strang, Introduction to Linear Algebra, 4th Edition, Cambridge Press (2009).
- S. Kumaresan, Linear algebra - A Geometric approach, Prentice Hall of India (2000).
- S. Lang, Introduction to Linear Algebra, 2nd Edition, Springer (2012).

Problem Solving with Programming (IT1001)

Objective: Students will be able to understand programming language (in this case C language), develop a problem solving approach from programmer's perspective.

Course Outcome

Students will be able to:

- break down complex real-world problems into smaller, manageable subproblems and develop logical approaches for solving them through programming.
- learn to debug code, identify and fix logical errors, and write test cases.
- develop a systematic approach to problem-solving, logical reasoning, and iterative refinement.

Introduction to Computers & Demo

Computer hardware, Computer Networks, IP Address, Proxy, Gateway, Operating Systems, Disk/Directory/Files system, Application Software. Professional Ethics.

Programming Basics: Structure of a simple C program, Constants and Variables, Basic Data Types, Precedence and Associativity, implicit and explicit type conversion, Selection Statements, Loop Structures

Functions and Arrays: User-defined functions, function definition, Storage class and Scope, Macros, Nested, and Recursive Functions, One Dimensional arrays, Passing Arguments, Two and higher Dimensional Arrays, Strings, String Library Functions

Pointer and Structure: Addresses and Pointers, Structures, Dynamic Memory Allocation, Linked List, Stack, Queue. Data Files.

Text Books

- "Engineering Problem Solving with C", Delores M. Etter, Fourth Edition, 2012, Pearson.
- "C: How to Program", Paul Deitel and Harvey Deitel, Ninth Edition, 2022, Pearson.

Reference Books

- "Computer Systems: A Programmer's Perspective", Randal E Bryant and David R O'Hallaron, Third Edition, 2015, Pearson.
- "Problem Solving and Program Design in C", Jeri R. Hanly and Elliot B. Koffman, Eighth Edition, 2015, Pearson.
- "Programming in C", Brian Kernighan and Dennis Ritchie, Second Edition, 2015, Pearson.

Fundamentals of Electrical and Electronics Engineering (EC1001)

Objective: Students will be able to understand the fundamental concepts of electrical and electronics engineering.

Course Outcome
Students will be able to:

- Understand working principles of basic electrical and electronic devices and circuits.
- Design basic electronic circuits

Introduction
Basic physical laws, circuit elements, KVL, KCL, Network Theorems

Transients
R-L, R-C, R-L-C, Sinusoidal Steady State, Real/Reactive Power, Three Phase,

Transformers/AC/DC machines
Working Principles of Transformers/AC/DC machines

Semiconductors
Semiconductors, Band Diagram, n-type and p-type semiconductor, junction diode, diode biasing, Zener diode, DC Power supply

Transistors
Introduction to Bipolar Junction Transistor, MOS Capacitor, Introduction to Operational Amplifier, Schmitt Trigger, Multivibrator, Oscillators

Text Book

- Microelectronic Circuits SEDRA/SMITH 7th Edition Oxford University Press
- Fundamentals of Electrical Engineering, Leonard S Bobrow, 2nd Edition, Oxford Press.
- Fundamentals of Electrical Engineering and Electronics, B L Thereja, S Chand Press.

References

- Network Analysis, M E Van Valkenberg, 3rd Edition, PHI, 2000
- Linear Circuit Analysis: Time, Domain, Phasor and Laplace Transform Approaches, R A DeCarlo and M Lin, 2nd Edition, Oxford University Press, 2000

Technical Communication Skills (MS1001)

Objective: Students will be able to enhance and polish communication skills which will formally help them to be effective professionals by understanding importance of effective communication, presentation and designing of work.

Course Outcome
Students will be able to:

- Speak and participate in GD
- Write technical letters, CV, product development plans etc

Introduction
Introduction to types of communication, Lab sessions and mock presentation pertaining to Communication Styles, Content Management and Delivery Making Effective Public presentations, Speech and diction correction and counseling

Formal communication
Written communication, Problems and solutions Lab sessions will have exposure to: Cover letter, CV preparation Group discussion and Personal Interview Report writing and Proposal development plan, Interview: types and techniques SWOT Analysis.

Reference Books

- Winning at Interviews by Edgar Thorpe Books on Technical Writing

Constitution of India (MS1002)

Objective: Students will be able to understand the Fundamental features of the Indian Constitution, Union Government, Rights and Duties, Statutory Institutions.

Course Outcome
Students will be able to:

- Understand Indian Constitution, its composition and functions, Union and state Government
- Understand Rights and Duties, Statutory Institutions etc

Introduction
Evolution of the Indian Constitution, Acts, Fundamental features of the Indian Constitution, Union, State and Local Government.

Rights and Duties
Fundamental Rights and Duties, Directive Principles, Relation between Federal and Provincial units: Union-State relations, Administrative, legislative& Financial, Inter-State Council, NITI Ayog, Finance Commission of India, Union List, State List, Concurrent List, Statutory Institutions: Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

Reference

- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi
- Subhash Kashyap, Our Parliament, National Book Trust, New Delhi
- Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi

Universal Human Values (MS1003)

Objective: Students will be able to understand the human values.

Course Outcome
Students will be able to:

- Understand the importance of human values, family, society, nature etc.
- Develop commitment and courage to act.

Introduction
Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

Self Reflection
Right understanding Strengthening of self-reflection, Development of commitment and courage to act, Method to fulfill the human aspirations: understanding and living in harmony at various levels.

Reference

Professional Ethics (MS1004)

Objective: Students will be able to understand the awareness on Engineering Ethics and Human Values.

Course Outcome
Students will be able to:

- Understand social responsibility of an engineer etc.
- To appreciate ethical dilemma while discharging duties in professional life.

Values
Human Values Morals, Integrity, Work Ethics, Honesty, Courage, Empathy etc. Kohlberg's theory, Gilligan's theory, Models of Professional Roles.

Ethics
Codes of ethics, Challenger case study, Safety and Risk, The Three Mile Island And Chernobyl Case Studies, global issues, moral leadership

Reference

- Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.
- Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
- Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
- Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
- John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

Youth Empowerment and Skills (MS 1005)

Objective: To equip students with practical tools and techniques that will make them more creative, efficient, confident, clear-minded, stress-free, joyful and energetic

Course Outcome
Students will be able to:

- learn challenges and will learn group processes, talks, presentations and hands-on learning methodology that helps students to enhance their lives.
- Participate in Group discussions and role-plays to inculcate life-skills and human values
- Yoga Asanas and Pranayama to increase concentration & build confidence
- Breathing techniques (like the world-renowned and well-researched Sudarshan KriyaTM)
- Talks and Presentations to bring out attitudinal and behavioral changes towards achieving student excellence.

Personality Development
Personality Development Self-awareness, Emotional Intelligence / Coping with Emotions, Mind Management, Coping with Stress, Health and Nutrition, Social Adaptability and Effectiveness Effective Communication Skills, Interpersonal Relationship Skills, Lifestyle and Environment

Ethics
Ethics, Morality and Integrity, Time Management and Goal Setting, Professional Skills, Active Learning and Effective Learning Strategies, Decision Making

Reference

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Electronic Workshop (EC1002)

Objective: The objective of this course is to familiarize the students with the PCB design and SMT**.**

Course Outcome
Students will be able to:

- Fabricate design on PCB and
- learn SMT Fabrication and other aspects of SMT and PCB

Introduction
Introduction to System/PCB, Design the PCB

Fabrication on PCB
Full wave Rectifier & Flasher Circuit

Clipper and Clamper
Design and fabrication on PCB/SMT

Text Book

Reference Book

Digital Logic Design with HDL (EC1008)

Objective: The objective of this course is to familiarize the students with the design of digital systems using Verilog HDL**.**

Course Outcome

Students will be able to:

- Design digital circuits, strong skill set of Verilog HDL,
- Write Test bench and implementing any digital system on FPGA.

Introduction

Number System, r-1s complement, Sign and Magnitude Numbers, r's Complement Numbers, Gray Code, Boolean Algebra & logic minimization, k-map, Logic Family (BJT and CMOS based), Data-flow description using Verilog

Combinational Logic Design

arithmetic circuit design, Design using MSI components, Multiplexers and De-multiplexers, Encoder, Decoder Binary Adders, Subtraction and Multiplication. Structural design and implementation using Verilog HDL

Sequential Network

Concepts of Sequential Networks, State Diagram, Latches and Flip, Flops, Counters and Shift Registers, state machine, Finite state machine; HDL Implementation of Digital circuits, Behavioral description of sequential circuits using HDL

Memory Elements and Arrays Registers

RAM and ROMs, programmable logic array, Memories. Field Programmable Gate Array (FPGA), LUT, Slices, Semi-custom and Ful custom design, Implementation of the digital system on FPGA

Text Book

- M. Morris Mano, Michael D. Ciletti, "Digital Design with an Introduction to the Verilog HDL", 5th Edition, Pearson Education Inc

Reference Book

- Samir Palnitkar, "Verilog HDL: A Guide to Digital Design and Synthesis", Second Edition, Prentice Hall, Computer Arithmetic Algorithms, 2nd Edition by Israel Koren

Electronic Devices and Circuits (EC1004)

Objective: This course is designed for the students seeking an extensive understanding of electronic devices and circuits and problem solving techniques. Being a freshman and a core course in electronics engineering, the lucidity is maintained throughout.

Course Outcome
Students will be able to:

- Design electronic circuits, amplifiers and
- Independently to drill any real world problems related to EDC.

Semiconductors
Semiconductor Diodes& Circuits: Physical operation of p-n junction diodes, Light emitting diodes, photo diode, circuits

Small Signal and Large Signal Analysis
Small & Large Signal Analysis of BJTs and FETs.

Energy band diagrams
Flat-band pinch-off voltage, JFET, Complementary MOS (CMOS), V-I Characteristics.

Text Book

- S. Sedra, K. Carless Smith Microelectronics, , 7thEdition, Oxford University. Integrated Electronics, JMilllman and C Halkias, TMH Press.

Reference Book

Electronics Measurements and Instrumentations (EC1005)

Objective: To introduce students to the basics of measuring instruments. To make them aware of working and practical application of instruments and sensors.

Course Outcome
Students will be able to:

- Understand the working principle of various instruments that will help to make better use of measuring instruments.
- Will be able to use different kind of sensors and
- How to select a suitable measuring instrument for the any measurement

Static Characteristics and Errors
Measurements, classification of instruments, Static characteristics of measurement instruments, Types of errors, Loading effect.

Electronic Instruments for Measuring Basic Parameters
DC Voltmeters, AC Voltmeters, Ammeters, Shielding & grounding, CTPT. Oscilloscopes: Basic construction, working, Kinds of Oscilloscopes.

Signal Generation and measurement techniques
Sine wave generators, Harmonic distortion analyzer, Spectrum analyzer.

Transducers
Transducers Classification, Selection Criteria, Characteristics, Construction, Application of following of different transducers..

Text Books

- A.K. Sawhney, Puneet Sawhney,A Course In Electrical And Electronic Measurements And Instrumentation, DhanpatRai Publications, 2012 H. S. Kalsi, Electronic Instrumentation, 3 edition, McGraw Hill Education, 2017

Reference Books

Data Structures and Algorithms (IT1003)

Objective: To make student learn the linear and non-linear structures in which data can be stored and their pros and cons & to write algorithms using different data structures.

Course Outcome
Students will be able to:

- Understand data structures, linked-lists, trees, binary search trees, AVL trees, stacks, queues, priority queues, and hash-tables and graphs, ADT
- To apply & implement learned algorithm design techniques and data structures to solve problems.

Introduction, Arrays and Linked Lists
Basic Terminology, Elementary Data Organization, Asymptotic notations Efficiency of an Algorithm, Time and Space Complexity and trade-off**,** Single and Multidimensional Arrays, Sparse Matrices, Single, Double and Circularly Linked List, Header node based Linked List, Operations on a Linked List. Insertion, Deletion, Traversal, Polynomial Representation and Addition, Generalized Linked List

Abstract Data Types (ADT), Searching and Sorting, **Priority Queues**
Stacks: Primitive Stack operations (Push & Pop) Implementation and Application of stack, Queue Implementation and Applications, Doubly Ended Queue, Sequential search, Binary Search, Comparison Sorting Techniques, Efficient Sorting Techniques, linear sorting techniques, Queue Definition & Implementation.

Hashing, Trees & Graphs- Hash table, hash function, collison & resolution strategies, Linear and Quadratic Probing, Trees, Binary Tree Representation, Expression Tree, Binary Tree Traversals, Binary Search Trees, Sequential & linked Representations of Graphs, Adjacency Matrix, Adjacency List, Graph Traversals, Connected Components, Minimum Cost Spanning Trees, Prims & Kruskal algorithm, Dijkstra algorithm

Text Books

- E. Horowitz, S. Sahni, S. Anderson-Freed “Fundamentals of Data Structures in C”, Second Edition, 2008, Universities Press.
- R. Kruse et al. , *Data Structures and Program Design in C,* Pearson Education
- S. Lipschutz , *Data Structures, Schaum's Outlines Series,* Tata McGraw-Hill.
- Mark Allen Weiss, “Data Structures and Algorithm Analysis in C (DSAC)”, Second Edition, 2002, Pearson Education India.

Reference Books

- “Algorithms Design”, Jon Kleinberg and Eva Tardos, First Edition, 2013, Pearson.
- “The C Programming Language”, Brian W. Kernighan and Dennis M. Ritchie, Second Edition, 2015, Pearson Education India.
- “Introduction to Algorithms”, Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, Third Edition, 2009, MIT Press.

Network Synthesis and Analog Filters (EC1007)

Objective: To elaborate on the principles and applications of electrical network theorems for solving complex circuits and to analyze the steady-state & transient behavior of electrical networks using mathematical techniques.To introduce the fundamentals of filter design and their implementation in signal processing systems

Course Outcome
Students will be able to:

- Apply electrical network theorems and mathematical techniques to analyze and solve complex circuits.
- Perform transient and steady-state analysis of RL, RC, and RLC circuits, including sinusoidal and frequency-domain responses.Design and implement passive and active filters for various signal processing applications.
- Analyze and synthesize two-port networks and evaluate their performance using standard parameter representations.

Basic elements of a network
Basic RL and RC circuits, RLC circuits. Network Theorems: Superposition, Reciprocity, Thevenin's, Norton's, Maximum Power Transfer.

R-L, R-C, R-L-C circuits
Initial conditions for networks, Differential equations, Transients in R-L, R-C, R-L-C circuits, Sinusoidal Steady-State Analysis, Laplace Transform Circuit Analysis in S-domain, Frequency Response of a Network, Design of Passive Circuits from Network Functions.

Two-Port Networks
Open Circuit Impedance Parameter (z Parameter), Admittance Parameter (y Parameter), Transmission Parameters, Hybrid Parameters (h Parameters), Two-Port Parameter Conversion, Interconnection of Two-Port Networks.

Filters
Passive Filters, Low Pass, High Pass, Band Pass, Band Reject Filters, OPAMP-Based Active Filters.

Text Books:

- M. E. Van Valkenburg, Network Analysis, Prentice Hall, 1955.
- Fundamentals of Electrical Engineering, Leonard S Bobrow, 2nd Edition, Oxford Press.
- Fundamentals of Electrical Engineering and Electronics, B L Thereja, S Chand Press.
- W.H. Hayt and J.E. Kemmerly: Engineering Circuit Analysis; 8th edition. McGraw-Hill, 2013.

Principles of Management (MS1006)

Objective: This course is designed to be an overview of the major functions of management. It explores how organizations develop and maintain competitive advantage within a changing business environment. Upon completion, students should be able to work as contributing members of a team utilizing these functions of management.

Course Outcome

Students will be able to

- Understand how organizations adapt to an uncertain environment and identify techniques managers use to influence and control the internal environment.
- Practice the process of management's four functions: planning, organizing, leading, and controlling.

Nature and Functions of Management

Importance and Process of Management, Development of Management Thoughts, Managerial Roles.

International Business and its Environment

Globalization & WTO, Dynamics of development Global business environment, Internal Tech. of Forecasting.

Need for Organization

Principles and Process of Organizing, Authority, Delegation and Decentralization

Staffing and Directing

Requirement of Effective Direction

Text Book

- Koontz, Weihrich, Aryasri. Principles of Management, TATA McGraw Hill, New Delhi, 2004.

References

- P. C. Tripathi, P. N. Reddy, Principles of Management, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Prasad LM, Principles and Practice of Management, Sultan Chand & Sons, New Delhi.
- Samuel C. Certo, S. TrevisCerto, Modern management 10 Ed, PHI Learning, New Delhi, 2008
- James A. Stoner, Edward Freeman, Daniel Gilbert, Management, PHI Learning, New Delhi, 2007
- Williams/ Kulshrestha, Principles of Management, Cengage Learning, New Delhi, 2011

Environmental Studies (MS1007)

Objective: To make student learn the importance of environmental studies, different resources, ecosystem etc.

Course Outcome

Students will be able to

- Understand the Multidisciplinary nature of environmental studies.
- Structure and function of an ecosystem
- Environmental Pollution etc.

Nature of Environmental studies, Ecosystems

Definition, Scope and importance, Need for public awareness. Different resources, Concept of an ecosystem, Structure and its function, Food chains, Different eco systems, Biodiversity, Threats, In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution & Field Work

Causes, effects and control measures of different pollution, Nuclear hazards, Pollution case studies, Disaster management, Water conservation, rain water harvesting, watershed management, Case studies on Environmental ethics, Climate change, global warming, Case studies. - Wasteland reclamation, Environment Protection Act, Water Act, Wildlife Protection Act, Visit to a local polluted site and Study of ecosystems.

References:

- Agarwal, K.C.2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt.Ltd. , Ahmedabad — 380 013, India, Email: mapin@icenet.net (R)
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc.480p
- Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
- Cunningham, W.P.Cooper, T.H.Gorhani, E &Hepworth, M.T.2001. Environmental Encyclopedia, Jaico Publ. House. Mumbai, 1196p
- Dc A.K., Environmental Chemistry, Wiley Eastern Ltd.
- Down to Earth, Centre for Science and Environment(R)
- Gleick, 11.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press. 473

Physical Education (Sports) (MS1008)

Objective: To aware the students on the importance of physical education for a healthy life and train them on various sports, games, yoga, etc. for physical fitness.

Course Outcome

Students will be able to

- Understand the knowledge of various ways for maintaining both physical and mental wellness

Know your body

First Aid for basic medical conditions, CPR for emergency, Diabetic and Obesity condition of Indian and world, Importance of physical education.

Yoga and Meditation

Yoga for wellness and concentration, Meditation for wellness

Athletics and Aquatics

Rules, benefits and mastering of various track and field events such as Sprint, Marathon, Hurdles, Long Jump, High Jump, Javelin throw, Shot Put, Discus throw, etc.

Rules, benefits and mastering of various styles of swimming, butterfly, freestyle, backstroke, and breaststroke, Sports for physical fitness like Cricket, basketball, football, volleyball, etc.

References:

- Dr. V K Sharma, “Health and Physical Education”. New Sarasvati House Publishers.
- “Yoga: A Healthy Way of Living”. By National Council of Educational Research and Training.
- Mark Young. “The Complete Beginners Guide to Swimming”.
- Dr. Ashwini Bhardwaj. “A Complete Guide to Family Safety and First Aid”. GoodWill’s Publishers.

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Electromagnetic Field and Waves (EC2001)

Objective: To let the Second Semester B. Tech. (ECE) students exposed to basic laws of Electromagnetism and to demonstrate their application on RF Communication.

Course Outcome

Students will be able to:

- Understand the different types of coordinate systems Divergence and Stokes's Theorems.
- Learn boundary conditions, Maxwell's equations and its applications.
- Visualize wave propagation in different medium.
- Apply Smith chart to solve problems of Transmission lines

Vector Calculus

Cartesian, Cylindrical and Spherical Coordinates systems, Line, Surface, and Volume Integrals, Gradient, Divergence, Curl and Laplacian, Divergence and Stokes's Theorems

Electromagnetic Fields

Review of Static Electric and Magnetic Field, Boundary Conditions of Electric and Magnetic fields, Electrostatic Boundary Value Problems: Poisson and Laplacian equations and its solution, Time varying fields, Maxwell's equations for time varying fields

Wave Propagation

Wave equation and its solution, Propagation of wave in lossless, lossy and conducting medium, Power and Poynting Theorem, Wave Polarization: Linear, circular and Elliptical. Reflection of a Plane Wave at Normal Incidence, Reflection of a Plane Wave at Oblique Incidence

Transmission line

Transmission Line Parameters, Transmission Line Equations, Input Impedance, Standing Wave Ratio, Smith Chart: Basic Operation of Smith Chart, Impedance matching: Single Stub, Double Stub, Quarter wave matching Techniques

Text Books

- N. O. Sadiku, Elements of Electromagnetics, 5th Edition. Oxford University Press, 2010.
- W H Hayt and J A Buck, Engineering Electromagnetics, Oxford University Press, 2000

Reference Books

- K. Shevgaonkar, Electromagnetic Waves, 1st Edition. McGraw-Hill, 2006.
- F. Harrington, Time-Harmonic Electromagnetic Fields, 2nd Edition. Wiley-IEEE, 2001.
- K. Cheng, Field and Wave Electromagnetics, 2nd Edition. Pearson, 2014.

Signals and Systems (EC2002)

Objective: To demonstrate an understanding of the fundamental properties of signal and systems.

Course Outcome

Students will be able to:

- Analyze the different types of signals and systems.
- Determine the linearity, causality, time-invariance and stability properties of continuous and discrete time systems.
- Represent continuous and discrete systems in time and frequency domain using different transforms.
- Recognize the characteristics of linear time invariant systems.

Classification of Signals and Systems

Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids. Classification of signals: Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals Classification of systems CT systems and DT systems: Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable

Continuous Time Signals & Linear Time Invariant Continuous Time Systems

Fourier series for periodic signals Fourier Transform and properties, Laplace Transforms and properties. Impulse response, convolution integrals, Differential Equation, Fourier and Laplace transforms in Analysis of CT systems, Systems connected in series / parallel.

Analysis of Discrete Time Signals

Sampling and Quantization, Discrete Fourier Transform and Properties, Discrete Fourier transform (DTFT) and Properties of DTFT, Z Transform and Properties of Z- Transform.

Linear Time Invariant-Discrete Time Systems

Impulse response, Difference Equations-Convolution sum- DFT & Z Transform Analysis of Recursive & Non-Recursive systems-DT systems connected in series and parallel

Text Books

- “Signals and Systems”, Simon Haykins and Barry Van Veen, 2nd Edition, 2008, Wiley India. ISBN 9971-51-239-4.
- “Signals and Systems” Alan V Oppenheim, Alan S, Willsky and A Hamid Nawab, Pearson Education Asia / PHI, 2nd edition, 1997. Indian Reprint 2002

Reference Books

- “Fundamentals of Signals & Systems”, Michael Roberts, 2nd edition, Tata McGraw-Hill, 2010, ISBN 978-0-07-070221-9.
- “Linear Systems and Signals”, B. P. Lathi, Oxford University Press, 2005.
- “Digital signal processing: principles algorithms and applications” Proakis, John G. : Pearson Education India, 2001

Analog Electronics and Linear ICs (EC2003)

Objective: To demonstrate an understanding of the analog electronics and linear integrated circuits

Course Outcome
Students will be able to:

- Understanding the types of amplifiers for analog electronics applications.
- Know the concept of various positive and negative feedback in electronic circuits.
- Solve circuits for designing ICs for applications in semiconductor industries.
- Become proficient in the analysis and design of circuits utilizing modern transistors.
- Understand the designing concept of power amplifiers in terms of the conversion efficiency and power delivered to the load.

Operational Amplifier
Type of Amplifiers, Op-Amp, non-idealities of Op-Amp, equivalent circuit, 741-IC, Op-amp used in negative feedback: inverting, non-inverting amplifier, integrator, differentiator, Instrumentation amplifier, Op-Amp as computational block

Feedback Systems
Properties of feedback system, Barkhausen criterion, Op-Amp with positive feedback, Oscillators, wave shaping circuits, filters, 555 timers, Schmitt Triger, PLL

MOSFET amplifiers
CSA, CGA, CDA, Cascode, Cascade, pole and zeros calculation, 3-dB bandwidth, current mirror.

Power amplifiers
Power amplifier circuits, Class A output stage, class B output stage and class AB output stages, class C amplifiers, push pull amplifiers with and without transformers. Complementary symmetry & quasi complimentary symmetry amplifiers.

Text Books

- Adel S. Sedra, Kenneth C. Smith, Microelectronics Circuits Theory and application, 6th edition, Oxford press.
- Behzad Razavi, "Design of Analog CMOS Integrated Circuits", 2nd edition, McGraw Hill, 2017
- R Gayakwad, “Op-amp and Linear Integrated Circuits”, 4th Ed.,Pearson Education.2005

Reference Books

- J Millman and C Halkias, Integrated Electronics by, TMH Press, 1995.
- W D Stanley, “Operational Amplifier with Linear Integrated Circuits”, 3rd Ed.,

Microprocessor Interface and Programming (EC2004)

Objectives: Students will be able to learn about the architecture of microprocessors, fundamentals of assembly language programming, interfacing with peripheral devices and enabling them to create products and solutions for real time problem.

Course Outcome

At the end of this course, students will demonstrate the ability to:

- Explain 8086 architecture and its instruction set
- Develop assembly language programs for the 8086 microprocessor
- Design memory organization
- Interface peripheral chips with respect to PPI, timer, DMA controller etc
- Describe the interrupt response of 8086 family processors and understanding of multi-processor system.

Introduction to Microprocessors

Introduction of Microprocessors and Micro-controllers, Concept of Pipelining, CISC and RISC, Von Neumann vs Harvard architecture, Different microprocessor family, features and evolution

8086 processors and Interrupts

8086 Architecture, Instruction Set, Minimum and Maximum mode configurations, Interrupts, Programmable Interrupt Controller 8259, Architecture, Commands, Interfacing

Peripherals and Interfacing

8255 Programmable Peripheral Interface, Architecture, Commands, Modes, Interfacing
8254 Programmable Interval Timer, Architecture, Modes, Concept of DMA

Memory Design, Multiprocessors and Advanced Microprocessors

Memory Design, Multiprocessor systems, Problems in Multiprocessor systems, Bus Contention, Features and Architecture of Pentium 80586, Microcontrollers

Text Books

- D.V. Hall, Microprocessors and Interfacing, 3rd Edition, McGraw Hill, 2017.
- K M Burchandi, A K Ray, Advanced Microprocessor And Peripherals 3rd Edition McGraw Hill, 2017.

Reference Books

- J. E. Uffenback, 8086/8088 Family rd Edition (English) 3rd Edition, Prentice Hall 2013.
- Y. Gandole, A Text Book Of Advanced Microprocessors and Microcontroller: Intel 80286,80386,80486, 80586 Microprocessor and 8051 Microcontroller, Lambert Academic Publisher, 2012.

Biology for Engineers (AS1010)

Objective: The objective is to provide the fundamental knowledge of Modern Biology and its application.

Course Outcome

Students will be able to:

- Get basic understanding of the Advanced Biology
- Get exposure to different areas of Biology including Cell Biology, Microbiology, Molecular Biology, Biochemistry and Immunology.
- Learn the principles of different advanced laboratory techniques used in biological research works and interdisciplinary research.

Introduction

Introduction to living organisms, Different cell organelles and cellular processes. Prokaryotes and Eukaryotes cells.

Structures and functions

Structures and functions of bimolecules, DNA, RNA, Carbohydrates, Proteins and Lipids.

Immunity, Electrical signal & Biomaterials

Antigen, Antibody, Antigen-Antibody interactions, Electrical signal of cells, HH model. Concept of Stem cells, Differentiation, Characterization**,** Biomaterials for tissue engineering, 3D bio-printing, DNA origami and Biocomputing.

Text book

- Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, and Peter Walter, Molecular Biology of the Cell.

References

- Prescott, Harley, and Klein's Microbiology by Joanne M. Willey, Linda Sherwood, and Christopher J. Woolverton.
- Biochemistry by Jeremy M. Berg, John L. Tymoczko, and Lubert Stryer.
- Immunology by Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby.

Principle of Economics (MS2001)

Objective: This course introduces economic analysis of individual, business, and industry choices in the market economy. Topics include the price mechanism, supply and demand, optimizing economic behavior, costs and revenue, market structures, factor markets, income distribution, market failure, and government intervention. Upon completion, students should be able to identify and evaluate consumer and business alternatives in order to achieve economic objectives efficiently.

Course Outcome

Students will be able to:

- Understand that economics is about the allocation of scarce resources, that scarcity for ceschoice, tradeoffs exist and that every choice has an opportunity cost.
- List the determinants of the demand and supply for a good in a competitive market and explain how that demand and supply together determine equilibrium price.
- Understand the role of prices in allocating scarce resources in market economies and explain the consequences of price controls.
- Define an externality and a public good and why explain the presence of externalities and public goods make markets inefficient. Analyse various government policies aimed at solving these inefficiencies.

Introduction to Economics

Production Possibilities, Supply and demand, analysis; The price system and the mixed economy

Elasticity; Consumer choice and the theory of demand

The profit-maximizing competitive firm and market supply; Long-run supply in competitive markets, Production and cost

Types of Market:

Monopoly; Perfect Markets; Monopolistic competition and oligopoly; Antitrust policy and regulation of markets

Introduction to macro Economics

Macro-Economic Equilibrium GDP; Unemployment; Inflation

Text Books

- Principles of Economics: Gregory Mankiw
- Economics: Samuelson

Introduction to Finance (MS2002)

Objective of the Course: This course is a rigorous introduction to the study of the basic principles of finance and their application to the usual financial issues and decision-making of business enterprises. The main objective of this course is for the student to obtain at least a good working-knowledge of the topics stated in the tentative course outline below for use in future courses and for careers.

Course Outcome
Students will be able to:

- Identify the objective of the firm and the role of managerial finance.
- Outline the implications of the separation of ownership and control.
- Evaluate financial statements using ratio analysis.
- Explain the general concept of valuing financial assets.
- Explain the characteristics of debt and equity securities.
- Identify why firms need to invest in working capital Outline the alternative sources of long-terms fund.

Introduction to financial Management
Financial statement basics, Ratio Analysis

Time value of Money
Capital Budgeting, Relationship between risk and return

Long term financial decisions
Working Capital Management, Dividend Decision

Introduction to Financial Systems
Capital Markets, Introduction to International finance and risk Management

Text Books ·

- Ross, Westerfield, Jordan, Essentials of Corporate Finance
- James C. Van Horne and John M Wachowicz, Fundamentals of financial management.
- Jonathan Berk, Financial Management

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Control Systems (EC2005)

Objectives: To introduce them to the basic of control systems. How a basic control system is formed? How they can analyze and build a control system.

Course Outcome

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

- analyze a control system if given to them. They will
- be able to find the equivalent mathematical model for it and if the system is
- not stable they will be able to, by the use techniques learned in this course,
- stabilize the system.

Introduction to Control System

Basic Concepts of Control Systems, Feedback characteristics of Control Systems.

Time response Analysis

Standard Test Signals. Time response of different order of systems. concept of stability.

Frequency Response Analysis

Frequency domain specifications, Gain and Phase Margin.

Stability in frequency domain

Root locus concepts, Effect of adding open loop poles and zeros, Nichol's chart, controllers.

Text Books

- N S. Nise, Control Systems Engineering, International Student Version, 6th Edition, Wiley, April 2011.
- R H. Bishop, Richard C. Dorf, Modern Control Systems, 12th edition, Pearson
- Higher Education, 2010.
- I.J. Nagrath and M Gopal, Control Systems Engineering, 6th edition, New Age International Pvt Ltd, 2017

Reference Books

Analog Communication (EC2006)

Objectives: To make the student learn the fundamentals of communication systems and to let the students be exposed to technological progress in communication systems.

Course Outcome

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

- analyze and design various transmission techniques.
- to tackle the challenges in designing a transceiver for a communication system..

Introduction

Basic elements of a communication systems.

Analog Baseband and Bandpass Transmissions:

Baseband versus passband communication,
Modulation and need of modulation, Analog modulation and demodulation- AM, DSB-SC, VSB, SSB, Comparison of different modulation techniques, Phased locked loop and applications, Pulse modulation: PAM, PPM, PWM..

Angle Modulation and demodulation

Non-linear modulation and concept of instantaneous
frequency, Relationship between PM and FM, Power and bandwidth of angle modulated signals, Narrowband and wideband FM, NBFM generation-direct and indirect method, Demodulation of FM signals and effect of non-linear distortion, Deemphasis and Preemphasis Filtering, Superheterodyne analog AM/FM receivers.

Noise in analog modulation systems

White Gaussian noise, Bandpass noise, PSD of noise, Noise analysis-DSB-SC, AM, SSB, FM.

Text Books

- A B Carlson, Communication, Pearson, 2000
- B P Lathi and Z. Ding, Modern Analog and Digital Communication Systems, Oxford Press, 2002

Reference Books

CMOS VLSI Design (EC2007)

Objectives: To make the student learn the fundamentals of design styles used in CMOS ICs, covering both full-custom and semi-custom design approaches.

Course Outcome

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

- Understand the fundamentals of MOSFET, CMOS Technology, and Scaling.
- Understand the fundamentals of the CMOS static and dynamic logic implementation and physical design
- Apply logic optimization techniques to improve the PPA of any CMOS ICs.
- Perform physical design and static timing analysis (STA).
- Make the skillsets aligned with India's semiconductor mission and VLSI industry.

Introduction to CMOS

MOSFETs, threshold voltage, Inverters: ratioed, ratioless, CMOS Inverter. DC transfer characteristics, Dynamic characteristics, Static and dynamic power consumption, standby power consumption, activity factor MOS leakage, delay computation using average current method, exact analysis, RC-delay model, interconnects, MOS capacitances.

Compact models and physical design

MOS SPICE Models, level-1, level-2, level-3, BSIM models, Verilog-A models, SPICE model parameter extraction, Short channel effects, Technology Scaling considering long-channel and short-channel transistors, CMOS Fabrication steps, Layout, stick diagram, Euler Path, junction sharing, calculation of parasitic. LVS, DRC, corner and PVT analysis, yield, PPA.

Combinational Logic Optimization

Pass transistors, CPL, Transmission gates, DCVSL logic, input reordering, progressive sizing, method of logical effort, critical path optimization using logical effort and RC-delay model.

Sequential Logic Implementation

Master-slave D-FF implementation using pass transistor and/or transmission gate, setup time, hold time, Static timing analysis, Min and Max delay constraints, hold time violation, clock skew, STA, dynamic logics: charge-precharge based, Dominos, charge-sharing.

Text Books

- J. M. Rabaey et al. & Digital Integrated Circuits A design perspective 2 nd edition, PHI.
- Weste, Harris, CMOS VLSI Design: A Circuits and Systems Perspective 4th edition, Pearson.
- Sung-Mo Kang, Yusuf Leblebici, CMOS Digital Integrated Circuits Analysis
- and Design Tata McGraw-Hill.

Reference Book

Probability and Statistics (AS2001)

Objective: This course provides an elementary introduction to probability and statistics with applications. The topics covered in this course are basic concept of probability and statistics, random variables, probability distributions, Bayesian inference, joint probability distributions, random vectors, central limit theorem, confidence intervals.

Course Outcome

Students will be able to:

- Understand the basic concepts of probability and random variables.
- Apply the standard discrete and continuous probability distributions to real problems and use the inequalities.
- Extend the concept of random variables to higher dimensions and approximate probabilities by central limit theorem.
- Analyze the data by using statistical techniques of point and interval estimation and testing of hypotheses.

Probability: Axiomatic definition, Properties, Conditional probability, Bayes rule and independence of events, Random Variables, Distribution function

Probability Distributions: Discrete and Continuous random variables, Expectation, Function of random variable, Moments, Moment generating function, Chebyshev's and Morkov's inequality. Bernoulli, Binomial, Geometric, Negative binomial, Hypergeometric, Poisson, Discrete uniform, Continuous uniform, Exponential, Gamma, Normal.

Random vector: Joint distributions, Marginal and conditional distributions, Moments, Independence of random variables, Covariance, Correlation, Levy's Central limit theorem (independently and identically distributed with finite variance case), Normal approximation to Binomial and Poisson

Statistics: Introduction: Population, Sample, Parameters, Point Estimation: Method of moments, Maximum likelihood estimation, Unbiasedness, Consistency, Interval Estimation: Confidence interval, Tests of Hypotheses, Linear Regression.

Text/Reference Books

1. Sheldon M. Ross, An Introduction to Probability Models, 10th Edition, Academic Press, Elsevier.
2. Sheldon M. Ross, An Introduction to Probability and Statistics for Engineers and Scientists, 3rd Edition, Academic Press, Elsevier.
3. Rohatgi, V. K. and Saleh, A. K. (2000), An Introduction to Probability and Statistics, 2nd Edition, Wiley-interscience.
4. Bertsekas, D. P. and Tsitsiklis, J. N. (2008), Introduction to Probability, Athena Scientific, Massachusetts.
5. Montgomery, D. C., Peck, E. A. and Vining, G. G. (2012), An Introduction to Linear Regression Analysis, 5th Edition, Wiley

Antenna and Wave Propagation (EC2009)

Objectives: To provide a comprehensive introduction to the fundamentals of antenna, its types, design and measurement parameters.

Course Outcome

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

- Learn the basics of radiation principle and foundational concepts through mathematical analysis.
- Gain insight about fundamental parameters and terminology used in Antenna Engineering.
- Analyze and design various types of antennas to achieve a specified performance.
- To understand various modes of EM wave propagation.
- To acquire hands-on experience with antenna measurements and testing

Radiation Integrals and Auxiliary Potential Functions

Vector Potential for an Electric and Magnetic Current Sources, Electric and Magnetic Fields for Electric and Magnetic Current Sources, Solution of the Inhomogeneous Vector Potential Wave Equation, Far-Field Radiation, Duality Theorem, Reciprocity and Reaction Theorems.

Fundamental Parameters of Antennas

Principle of Radiation, Radiation Pattern, Field Regions, Radiation Power Density, Radiation Intensity, Beamwidth, Directivity, Antenna Efficiency, Gain, Bandwidth, Polarization, Input Impedance, Antenna Radiation Efficiency, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation.

Antenna Arrays

Uniform linear arrays of isotropic elements, array factor and directivity. Broadside & Endfire array, Principle of pattern multiplication. Binomial array.

Working Principle of Antennas & Wave Propagation

Linear Wire Antennas, Monopole, folded dipole, Yagi-Uda, Log
periodic, Parabolic reflector, Horn, V-antenna, Rhombic antenna, Microstrip antenna, Resonant and non-resonant antenna. Atmosphere, Ground wave propagation, Sky-wave propagation, space wave, propagation, Troposcatter and Duct propagation

Text Books

- C A Balanis, Antenna Theory and Design.3rd Ed., John Wiley & Sons. 2005.
- R. Harish, and M. Sachidananda. Antennas and wave propagation. Oxford University Press, USA, 2007.
- Reference Books
- R. S. Elliot, Antenna Theory and Design. Revised edition, Wiley-IEEE Press. 2003.
- R. E. Collin, Antennas and Radio Wave Propagation. McGraw-Hill. 1985.
- R. K. Shevgaonkar, Electromagnetic waves. Tata McGraw-Hill Education, 2005.

Integrated Circuit Technology (EC2010)

Objectives: The subject provides an in-depth knowledge of how a semiconductor device is prepared right from the substrate preparation to device fabrication..

Course Outcome

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

- Achieve in-depth knowledge of how a semiconductor device is prepared right from the substrate preparation to the final device realization.
- Understand the latest device fabrication technologies and basic principles underlying state-of-the-art processes involved

Semiconductor materials and manufacturing

Historical perspective, Modern CMOS Technology, Crystal growth, and wafer preparation: crystal structures, wafer fabrication, crystal defects, gettering

Lithography

Light Sources, Masks, Wafer Exposure System, Photoresists, Modern Photolithography Techniques, DUV, EUV, Resolution enhancement methods, Other lithography Techniques

Thermal Oxidation and Interfaces

Oxidation kinetics and its dependencies, substrate doping effects, impurity redistribution during oxidation, oxide charges, High-K Dielectrics

Doping in Semiconductors & Etching Technologies

Diffusion from Macroscopic and microscopic viewpoint, Analytical solutions of Diffusion equation, evaluation of diffused layers, Ion Implantation and implant range, Ion stopping and ion channelling, Transient Enhanced Diffusion (TED), Wet and dry etching, Plasma chemistry, plasma etching mechanisms, high density plasma, atomic layer etching, planarization methods CMP

Deposition Technologies and Interconnects

CVD, hetroepitaxy, PVD, sputtering systems, LPCVD, MOCVD, PECVD, ALD, MBE, Metal deposition, multilayer interconncets and their issues, Electromigration silicidation, salicide process

Text Books

- J. D. Plummer and P.B. Griffin, “Integrated Circuit Fabrication Processes: Science and Technology”, by Cambridge University Press, 2024

Reference

- S. M. Sze, VLSI Technology, McGraw Hill Education.
- G. S. May and S M Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons,
- S. K. Gandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, John Wiley & Sons,

Digital Signal Processing (EC3001)

Objective: To learn about the basics and advanced topics in the field of Digital Signal Processing.

Course outcomes

Students will be able to:

- Students will learn to utilize the advanced approaches of processing the signals and various aspects of discrete system design.

Introduction

Review of the fundamental concepts of digital signal processing, Sampling and Quantization, Convolution and correlation, DTFT, DFT and FFT

FIR & IIR

Filter concepts, Structures for realization of FIR and IIR Systems and their analysis, Recursive and Non-recursive structures, Windowing methods, comparison of design methods.

Multirate DSP

Design of FIR filters, Analysis of finite word length effects, Multirate digital signal processing, optimum linear filters and Power spectrum estimation.

Statistical Signal Processing

Introduction to Statistical Signal Processing, applications of autoregressive (AR), Moving average (MA), and ARMA processes, Applications of DSP etc.

Text Books:

- John G Proakis, Digital Signal Processing, 4th Edition PHI, 2012
- V. Oppenheim and R. W. Schafer, Discrete-Time Signal Processing, 2nd Edition,
- Pearson Education, 2003.
- J. G. Proakis and D. G. Manolakis, Digital Signal Processing: Principles, Algorithms
- and Applications, 4th Edition, Prantice Hall, 1996.
- S. Haykin and B.V. Been, Signals and Systems, 2nd Edition, John Wiley & Sons. 2003.
- B.P. Lathi, Linear Systems and Signals, 2nd Edition, Oxford University Press, 2005.

Reference Books:

Embedded System Design (EC3002)

Objective: Understanding of Hardware and Software Components of a typical Embedded System, the challenges in " System Level Design" and develop system design skills and to Develop programming skills and practical expertise in designing, debugging and developing small scale and medium scale Embedded systems

Course outcomes

Students will be able to:

- Understand the hardware and software components of embedded systems.
- Develop system design skills and address challenges in system-level design.
- Gain practical expertise in designing, debugging, and developing embedded systems.
- Ability to design embedded electronic hardware and firmware.
- Comprehend microcontroller architecture and interfacing techniques

Introduction

Design process of embedded systems, hardware/software interface, design issues in embedded systems, and system-on-chip technologies.

Implementation

Hardware implementation methodologies, interaction for general microcontrollers, and communication protocols like USB, I2C.

Embedded Processor

Performance, efficiency of ARM architecture, data processing, and parallelism.

Interfacing

Memory interfacing, I/O interfacing, real-time OS, scheduling, and testing.

Text Books

- Wolf, Wayne. Computers as Components – Principles of Embedded Computing System Design. Second Edition, Morgan-Kaufmann, 2008.
- Vahid, F., & Givargis, T. Embedded System Design – A Unified Hardware/Software Introduction. John Wiley, 2002.

Reference Books

- James K. Peckol. Embedded System Design – A Contemporary Design Tool. Wiley Student Edition, 2010.
- Steve Furber. ARM System-on-Chip Architecture. Second Edition, Pearson, 2007.
- Lyla B Das. Embedded Systems: An Integrated Approach. Pearson Education.
- Santanu Chattopadhyay. Embedded System Design. PHI.
- Muhammad Ali Mazidi. 8051 Microcontroller & Embedded Systems: Using Assembly and C. Pearson Education.
- ARMv7 Reference Manual.

Microwave Engineering (EC3003)

Objective of the course: To provide a comprehensive introduction to various devices and passive components used at microwave frequencies.

Course Outcomes
Students will be able to:

- Understand the different types of matching techniques using Smith Chart.
- Analyze and implement metamaterial transmission lines.
- Design RF filters using planar technologies.
- Design microwave amplifiers.

Impedance Matching
Smith Chart, Single and double stub matching, Quarter-wave Transformer, Theory of Small Reflection, Binomial and Chebyshev multi-section matching, Tapered line

Metamaterial Transmission lines
Negative Refractive Index (NRI) Media, Negative-Refractive-Index Transmission-Line (NRI-TL) Metamaterial Medium: Propagation Characteristics of the T and Unit Cell, Effective Medium Propagation Characteristics, Multi-Stage NRI-TL Metamaterial Phase-Shifting Lines

Microwave Filters
Filter design by the insertion loss method, Maximally Flat Low-Pass Filter Prototype, Equal-Ripple Low-Pass Filter Prototype, Filter transformations: Impedance and Frequency Scaling, Band-pass and Band-stop Transformations, Richards' Transformation, Kuroda's Identities, stepped-impedance low-pass filters

Microwave Active Circuit Design
Nonlinear distortion: Gain Compression, Harmonic and Intermodulation Distortion, Third-Order Intercept Point, Dynamic range, Diode Circuits, Amplifier Design: Two port power gain, stability circles, Single stage transistor amplifier design

Text Books

- D.M. Pozar, Microwave Engineering. 4th Ed., John Wiley & Sons. 2012.
- R.E. Collin, Foundations for Microwave Engineering. 2nd Ed., John Wiley & Sons. 2000.

Reference Books

- D.M. Pozar, Microwave and RF design of Wireless System, John Wiley & Sons. 2001.
- Marc A. Antoniades, Microwave Devices and Antennas Based on Negative-Refractive-Index Transmission-Line Metamaterials, PhD Thesis, Department of Electrical and Computer Engineering University of Toronto, 2009.

Digital Communication (EC3004)

Objective: To learn about the fundamental concepts of digital communications.

Course Outcome:
Student will be able to:

- Understand the fundamental principles underlying the analysis and design of digital communication systems.
- Gain knowledge of digital communication methods for transmitting information from a source to one or more destinations in digital form.
- Evaluate the performance of digital communication system in the presence of noise.
- Apply the knowledge of information theory and describe the error control codes like block code, cyclic code.

Digital communication systems and signal representation
Analog versus digital communication, Elements of a digital communication system, Review of probability and random process, Signal spaces: Waveforms and vector spaces, Gram Schmidt orthogonalization, bandpass and low pass representation of a random process, Line Coding, Spectral properties of line codes.

Digital modulation and demodulation techniques
Baseband pulse shaping, Digital modulations and demodulation schemes: Binary ASK, PSK, FSK, QPSK, 8-PSK, DPSK, QAM, Calculation of probability of error.

Optimum signal detection
Design of optimum receivers over AWGN channel, Noise in digital communications, Equalizers.

Introduction to Information Theory
Entropy, Mutual information, Data compression, Source coding, Channel coding, Error correction codes.

Text Book

- B P Lathi and Z. Ding, Modern Analog and Digital Communication Systems, Oxford Press, 2002.
- John G Proakis and M. Salehi, Digital communications, McGraw-hill, 2008.

References

- S. Haykin, Digital communications, Wiley, New York, 1988

Design Thinking and Innovation (EC3501)

Objective: The objective of this course is to learn the innovation cycle of Design Thinking process for developing innovative products.

Course Outcome

Student will able to

- Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of the Design Thinking process for developing innovative products
- Propose real-time innovative engineering product designs and Choose appropriate frameworks, strategies, and techniques during prototype development and to perceive individual differences and its impact on everyday decisions and further Create a better customer experience

An Insight to Learning, Remembering Memory & Emotions

Kolb's Learning Styles, Assessing and Interpreting, Understanding the Memory process, Problems in retention, Memory enhancement techniques, Understanding Emotions:

Basics of Design Thinking & Being Ingenious & Fixing Problem

Definition, Need, Objective, Concepts & Brainstorming, Stages of Design Thinking Process, Bottlenecks of Processes-Process Centric approach, Creative thinking process, Problem Solving, Testing Creative Problem Solving

Process of Product Design, Prototyping & Testing and Celebrating the Difference

Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, User Interface Design, Mobile App Design, Prototype creation, Rapid Prototype Development process, Testing, Test Group Marketing, Group Discussion

Design Thinking & Customer Centricity & Feedback, Re-Design & Re-Create

Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Feedback loop, rapid prototyping & testing, final product, Creative Solution".

Text Book

Reference Book

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Data Communication and Networking (EC3005)

Objective: The objective of this course is to describe communication protocols and layered network architectures

Course outcomes:
Students will be able to:

- Explain convention computer system interfacing standards and peer-to-peer data link and communication protocols
- Design basis network systems and Analyze data communication technology
- Analyze data communication technology.

Data Communications
Components – Direction of Data flow – Networks – Components and Categories – Types of Connections – Topologies –Protocols and Standards – ISO / OSI model, Example Networks such as ATM, Frame Relay, ISDN Physical layer: Transmission modes, Multiplexing, Transmission Media, Switching, Circuit Switched Networks, Datagram Networks, Virtual Circuit Networks.

Data link layer: Introduction, Framing, and Error – Detection and Correction – Parity – LRC – CRC Hamming code, Flow and Error Control, Noiseless Channels, Noisy Channels, HDLC, Point to Point Protocols. Medium Access sub-layer: ALOHA, CSMA/CD, LAN – Ethernet IEEE 802.3, IEEE 802.5 – IEEE 802.11, Random access, Controlled access, Channelization.

Network and Transport Layer: Logical Addressing, Internetworking, Tunneling, Address mapping, ICMP, IGMP, Forwarding, Uni-Cast Routing Protocols, Multicast Routing Protocols, Process Process Delivery, UDP and TCP protocols, Data Traffic, Congestion, Congestion Control, QoS, Integrated Services, Differentiated Services, quality of service in Switched Networks.

Application Layer: Domain name space, DNS in internet, electronic mail, SMTP, FTP, WWW, HTTP, SNMP.

Text/Reference Books:

- D. Bertsekas and R. Gallager, Data Networks, 2nd Edn., Prentice Hall, 1992.
- L. Peterson and B. Davies, Computer Networks: A Systems Approach, 4th Edition, Elsevier, 2007.
- L Garcia and I. Widjaja, Communication Networks, 2nd Edn., McGraw Hill,2009
- Kumar, D. Manjunath and J. Kuri, Communication Networking: An Analytical Approach, Elsevier, 2004.
- Behrouz A. Forouzan, Data Communications and Networking, Fourth Edition TMH,2006.
- Andrew S Tanenbaum, Computer Networks, 4th Edition. Pearson Education, PHI.

Mobile and Wireless Communication (EC3006)

Objective: The objective of this course is to develop an understanding of advanced multiple access and diversity reception techniques.

Course outcomes:
Students will be able to:

- Synthesis and analysis of wireless and mobile communication systems over a stochastic fading channel
- Evaluate the performance of wireless communication systems, taking into account the impact of physical channel characteristics on end-to-end transmission.
- Identify the recent technologies in the domain of wireless communication

Cellular concepts: Fundamentals of cellular networks, Frequency reuse, Handoff, Co-channel interference, Adjacent interference, System capacity, Trunking and grade of service.

Mobile radio propagation: Free space propagation model, Log distance path loss model, Shadowing, Various outdoor and indoor propagation models, Types of fading, Doppler shifts, Characteristics of fading channel: level crossing and average fade duration, Diversity Techniques.

Multiple access techniques: Frequency division multiple access (FDMA), Time division multiple access (TDMA), Spread spectrum multiple access: CDMA and frequency hopping, Orthogonal frequency division multiplexing (OFDM).

Recent wireless technologies: Cooperative Communication: Relaying and other similar Networks, LTE Networks, NOMA and others recent trends in 5G and beyond.

Text Book

- T. S. Rappaport, Wireless Communication, 2nd Edition, Principles and Practice, Pearson Education India, 2009.
- Tse and P. Viswanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005

References

- B. Carlson, P. B. Crilly and J.C. Rutledge, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 4th Edition, McGraw Hill, 2002.
- L. Song and J. Shen, Evolved Cellular Networks Planning and Optimization for UMTS and LTE, 1st Edition, CRC Press, 2010.

French Language (MS 1502)

Objective: To equip students with the necessary skills to understand, speak, read, and write French effectively, allowing them to communicate in everyday situations, including basic grammar, vocabulary, pronunciation, and cultural understanding, often aiming to reach a specific proficiency level

Course outcome

At the end of this course, Students will

- be familiar with the pronunciation of French letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Personal Information, Introducing yourself (name, age, nationality), Family members Basic greetings and farewells

Basic Communication

Asking and answering simple questions, Expressing likes and dislikes, Making requests.

Numbers and Time

Counting, Telling time, Days of the week and months

Everyday Life

Describing daily routines, Talking about hobbies and interests, Weather descriptions

Places and Directions

Asking for and giving directions, Identifying basic places in a town

Shopping and Dining

Making simple purchases, Ordering food and drinks

Basic Grammar

Subject-verb agreement, Present tense verb conjugation, Basic sentence structure, Articles (le, la, les, un, une)

German Language (MS 1500)

Objective: The student will learn the basics of standard German language, and will get to know about the norms of language of German.

Course outcome

At the end of this course, Students will

- Be familiar with the pronunciation of German letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Alphabets, Numbers, Greetings

Phrases

Basic introductory phrases

Calenders

Days of the week, Months

Introduction of self and introduction of others

Map, Time, Vocabulary- things around, Nations and nationalities, stationery, professions, hobbies

Grammar

present tense, past tense, plurals, pronouns, verb conjugations, (regular, and three or four important irregular verbs), prepositions, and so on

Japanese Language (MS 1501)

Objective: The student will learn the basics of standard Japanease language, and will get to know about the norms of language of Japan.

Course outcome

At the end of this course, Students will

- Be familiar with the pronunciation of Japan letters and greetings
- would be able to count numbers
- would be able to form basic questions and answer them and would be able to read the city map, converse of time and appointments etc

Introduction

Introduction to Japanese Syllables (phonetic alphabet), greetings & Self introduction, Identifying things, point objects and listen to their names, Listen to things and places etc. Creating shopping lists

Time Delay

Introduction to Time, day of the week, simple inquiries on telephone, Means of transport, Basic conversations of everyday life.

Frame questions in Japanese

Vocabulary of giving and receiving objects. Stating impressions/things surrounding us, Expressing likes and dislikes, good/bad, possessions. Talking about the country, town and the environment.

Quantity

Number of people, time, period etc., Stating thoughts and impressions. Conveying movement (e.g. go / come)

Sanskrit Language (MS 1401)

Objective: The student will learn the basics of standard Sanskrit language, and will get to know its importance with respect to national unity, integrity, morality and spirituality.

Course outcome

At the end of this course, Students will be

- familiar with the pronunciation of Sanskrit language
- understand ancient scientific concepts, principles, and methodologies without the limitations of translations or interpretations

Introduction to Sanskrit Phonetics

Devanagiri Lipi: Swar and Vyanjan. (Writing rules,Definition,classification,Pronunciation system),Sanskrit Sentence formationand spoken Sanskrit rules.Translation:From Sanskrit to English or English to Sanskrit. Sanskrit Subhashita.

Sanskrit grammar

Sandhi (introduction, classification, Swar-Sandhi),Kāraka&Vibhakti (Definition, Types, Example). Sabdārūpa&Dhāturūpa.

Introductory Vedic & Classical Literature

Four Vedas, Āraṇyakas, Upaniṣads, Vedāṅgas, Purāṇas.Rāmāyaṇa(by Vālmīki) and **Mahābhārata** (by Vyāsa), Bhagavad Gita etc.

Introductory Vedic Mathematics and Sciences in Sanskrit:

Illustrations from book- Vedic Mathematics written by Bharati Krishna Teertha ji, (published by MLBD) –Calculation pi, square root finding, Philosophical meanings of zero and one. Surya Siddhanta. (Kalganana), Katapayadi Sankhya,NāradāŚilpa Śāstra(Architecture and Vastu Shastra), Aṣṭāṅga Hridayam.

Modern Age Possibilities: Sanskrit for ICT : Paper by Subhash Kak and Saroja Bhate Panini's Grammar and Computer Science.

Text Books:

- Sanskrit Sahitya ka Samikshatmak Itihas by Dr. Kapil Dev Dwivedi.

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M.TECH- IT

Applicable with effect from 2023 admitted batch and onwards

Mathematics for IT (IT 4001)

Objective: This course covers linear algebra, Matrix theory and probability (discrete & continuous) for information technology. The objective is to give fundamental knowledge to students and application on IT with more emphasis on problem solving

Course outcome

At the end of this course, Students will be able to

- learn fundamentals of Mathematics for IT and
- apply these knowledge in practical problems

Linear Equations

Systems of linear equations; Row reduction and echelon forms; Matrix operations, including inverses; Linear dependence and independence; Subspaces and bases and dimensions; Orthogonal bases and orthogonal projections; Gram-Schmidt process; Projections; Linear models and least-squares problems; Determinants and their properties.

Eigenvalues and eigenvectors

Eigenvalues and eigenvectors; Diagonalization of a matrix; Symmetric matrices; Positive definite matrices; Similar matrices; Linear transformations; Singular Value Decomposition.

Events and Probability Spaces

Events and Probability Spaces; Conditional Probability; Independence; Random Variables and Distributions; Expectation, Limit Theorems, Deviations; Markov Chains; Random Walks.

Text Books

- Gilbert Strang. Introduction to Linear Algebra.
- Bertsekas, Dimitri, and John Tsitsiklis. Introduction to Probability.

Advanced Programming Practices (IT 4002)

Objective: To revise basic programming skills and coding data structures for PG (IT) students

Course outcome

At the end of this course, Students will be able to

- revise their skills in basic programming and data structures.
- They shall have the ability to solve problems using basic data structures in C and will be poised to implement more complicated algorithms that they shall encounter in later semesters

Quick overview on C language

Pointers and arrays, Linked lists, Dynamic tables

Disjoint sets using trees

Hashing by chaining, Perfect hashing, Heaps using trees Search algorithms for graphs (DFS & BFS) Balanced trees, B-tree, Kruskal's algorithm, Eulerian path, Hamiltonian cycle

Shell scripts in Linux environment

Programming in bash and whiptail, Automatic testing using shell scripts.

Text Books

Reference

- Pro Bash Programming by Chris F.A. Johnson, Apress.
- C Programming Language (Ed 2) by Brian W. Kernighan and Dennis M. Ritchie, Prentice Hall
- Data Structures Using C and C++ by Yedidyah Langsam, Moshe J. Augenstein and Aaron M. Tenenbaum, Pearson
- Introduction to Algorithms (Ed 3) by TH Cormen, CE Leiserson, RL Rivest and C Stein, MIT Press.

Introduction to Machine Learning (IT 4003)

Objective: This course gives an introduction to machine learning. It is about unified understanding of the models and algorithms used in machine learning

Course outcome

At the end of this course, Students will be able to

- to understand basic concepts and they will be able to successfully apply it on real datasets.

Introduction to Machine Learning

Course Logistics, Supervised learning (Distance based methods - kNN), Decision Trees for Classification and Regression, Random Forest, Bagging, Boosting, Linear Regression

Learning via Probabilistic Modeling

(Naïve Bayes, MLE, MAP), Probabilistic Models for Supervised Learning: Discriminative and Generative Approaches, Basics of Convexity, Gradient Descent, Stochastic GD, Hyperplane based Classifiers (Perceptron and SVM), SVM Multiclass and One-Class SVM, Making Linear Models Nonlinear via Kernel Methods

Unsupervised Learning

K-means Clustering and Extensions Parameter Estimation in Latent Variable Models, Expectation Maximization, Model Selection, Evaluation Metrics, Learning from Imbalanced Data, Linear and Non-Linear Dimensionality Reduction (PCA, LLE, Isomap etc), Bias/Variance Trade-off, Some Practical Issues, Semi-supervised and Active Learning.

Introduction to Artificial Neural Networks

Introduction to Deep Neural Networks, Learning to Recommend via Matrix Factorization/Completion, Reinforcement Learning

Text Books

Reference

- Christopher Bishop, “Pattern recognition and machine learning”, Springer, 2007.
- Duda, Peter Hart, David Stork, “Pattern Classification”, Wiley; Second edition
- Tom Mitchell, “Machine Learning”.
- Hal Daumé III, A Course in Machine Learning (http://ciml.info), 2015
- Kevin Murphy, “Machine learning: a probabilistic perspective”, MIT Press, 2012.
- Etham Alpaydin, “Machine Learning”, (https://www.cmpe.boun.edu.tr/~ethem/i2ml3e/)
- Hal Daumé III, “A Course in Machine Learning (CIML)”, 2017 (freely available online)
- Kevin Murphy, “Machine Learning: A Probabilistic Perspective (MLAPP)”, MIT Press, 2012

Image and Video Processing (IT 4004)

Objective: To provide the basic understanding of digital image formation and visualization, relationships between spatial and frequency, the understanding of mapping the signal processing techniques to the digital image and to provide an idea of multimedia data (image, video) and exposure to various image and video compression standards

Course outcome

At the end of this course, Students will be able to

- apply the knowledge gained during the course to solve various real time problems.
- shall be able to develop new state of the art image and video processing methods.

Digital Image Fundamentals

Simple image model, digital image formation, sampling, quantization, resolutions and representation, relationship among pixels, types of digital images. Color Image Processing: Color Representation, Chromaticity Diagram and Color Spaces, types of digital imaging and application areas. Enhancement- Point Processing: Contrast Stretching, Power-law and Gamma Transformation. Histogram Processing: Histogram Equalization and Matching.

Filtering and Restoration

Degradation function and Noise Models, Spatial Domain Filtering: Correlation and Convolution, Smoothing Linear and Nonlinear Filters: Mean and Median Filters, Adaptive Filtering, Sharpening Linear and Nonlinear Filters: Derivative, Laplacian, Unsharp Masking, High-boost Filtering. Frequency Domain Filtering: Filtering: Low-pass (Smoothing) & High-Pass (Sharpening), Ideal, Butterworth and Gaussian Filtering, Unsharp Masking and High-Boost Filtering, Homomorphic Filtering, Periodic Noise Reduction and Inverse Filtering & Wiener Filtering.

Edges, Lines and Boundary Detection

First and Second Order Edge Operators, Multi-scale Edge Detection, Canny Edge Detection Algorithm, Hough Transform: Line and Edge Detection, Morphological Operations and Application: Boundary, Skelton, Convex-Hull, Thinning, Pruning etc. Segmentation & Feature Extraction: Model-based and probabilistic methods and Image Classification Optimal and Multilevel Thresholding, Gray Image Segmentation, Watershed Algorithm.

Compression

Lossy and Lossless compression techniques, JPEG, JPEG2000 and Variants, Introduction to video processing, Compression standards and formats (MPEG & H.XXX), Video Streaming.

Text Books

- Digital Image Processing (3rd Edition) by Willam K. Pratt, John Willey & Sons

Reference

Research Methodology & IPR (AS 4100)

Objective: To provide students with basic of research Methodology and IPR

Course outcome
At the end of this course, Students will be able to

- understand the basis basic of research Methodology
- have basic knowledge of IPR, patent filing and other related aspect.

Introduction
Research attitude & Choosing Research Problem.

Scientific Writing
Different types of scientific writing (thesis, paper, review, proposal, CV, Cover letter, popular article)

Communication
Communicating Science (research journalism, lecture, poster)

IPR
IPR, Plagiarism, use of computers, search engines, language and grammar, answering in interviews, Basic Statistical Concepts

Text Books

- Alley, M., 2003, The craft of Scientific presentations:Critical steps to succeed and critical errors to avoid, Springer, New York. Gustavii, B, 2003, How to write and illustrate a scientific paper, Cambridge University press, Cambridge
- Matthews J.R., Bowen J.M. and Matthews R.W. 2000, Successful scientific writing, a step-by-step Guide for the Biological and Medical Sciences, Cambridge University press, Cambridge
- Swales.M. & Feak C.B. 2000, English in today's Research world, A writing guide, University of Michigan Press, Ann Arbour
- Introducing Research Methodology: A Beginner's Guide to Doing a Research Project Second Edition by Uwe Flick (Author) ISBN-10: 1446294242
- The Research Methods Knowledge Base, 3rd Edition, by William M. K. Trochim and James P. Donnelly; ISBN-13: 978-1592602919; ISBN-10: 1592602916
- Research Design: Qualitative, Quantitative, and Mixed Methods Approaches, 4th Edition, by John W. Creswell; ISBN-13: 978-1452226101; ISBN-10: 1452226105
- Qualitative Research: A Guide to Design and Implementation 4th Edition, by Sharan B. Merriam and Elizabeth J. Tisdell; ISBN-13: 978-1119003618; ISBN-10: 111900361X
- Doing Your Research Project (Open Up Study Skills) 5th Edition, by Judith Bell; Paperback (2010)

Reference

Research Methodology-2 (AS 4200)

Objective: To provide students with basic statistical analysis mechanism and to provide statistical hands-on for beginning research

Course outcome

At the end of this course, Students will be able to

- understand the basis statistical analysis needed for research
- have basic knowledge of the software tools needed for statistical analysis and will have hands-on experience

Describing Data

Overview, Observations and Variables, Types of Variables, Central Tendency, Distribution of the Data, Confidence Intervals, Hypothesis Tests

Preparing Data Tables

Overview, Cleaning the Data, Removing Observations and Variables, Generating Consistent Scales Across Variables, New Frequency Distribution, Converting Text to Numbers, Converting Continuous Data to Categories, Combining Variables, Generating Groups, Preparing Unstructured Data, Visualizing Relationships Between Variables, Calculating Metrics About Relationships

Data Visualization

Visualization Design Principles, Tables, Univariate Data Visualization, Bivariate Data Visualization, Multivariate Data Visualization, Visualizing Groups, Dynamic Techniques

Hands-On Tutorials

Reading in Data, Preparation Tools, Tables and Graph Tools, Statistics Tools

Text Books

- A Practical Guide to Exploratory Data Analysis and Data Mining - I and II 2nd Ed. by GLENN J. MYATT WAYNE P. JOHNSON Wiley Publication 111900361X
- How to Keep Your Research Project on Track Edited by Keith Townsend, Mark N.K. Saunders

Reference

- Head First Statistics by Dawn Griffiths, O'Reilly, 2009

Deep Learning (IT 4005)

Objective: To get the students and researchers exposed to the state of the art deep learning techniques, approaches and how to optimize their results to increase its efficiency and get some hands-on experience on the same to digest the important concepts

Course outcome

At the end of this course, Students will be able to

- exposed to the background mathematics involved in deep learning solutions.
- deal with real time problems and problems being worked upon in industries.
- Accept the machine learning community – both as an intelligent software developer as well as a matured researcher.

Basic concepts of perceptron, learning and recognition

supervise and unsupervised learning. Fundamentals of delta learning rules and back propagation algorithm, SVM, KNN. Machine Learning, machine learning techniques, challenges motivating deep learning. over fitting and under fitting, bias and variance, Gradient based optimization, Maximum LikelihoodEstimation. Deep Feed-forward network, backpropagation. SomeRegularization and Optimization Techniques, Convolutional Neural Network, RNN, methodology and Applications of deep learning Linear Factor Models and Autoencoders, Monte Carlo Methods, Stochastic Maximum, Likelihood and Contrastive Divergence

Deep Generative Models

Boltzmann Machine, RBM, Deep Belief Nets, Deep Boltzmann Machine, Convolutional Boltzmann Machine

Text Books

- Deep Learning by- Ian Goodfellow, Yoshua Bengio and Aaron Courville

Reference

Probabilistic Machine Learning and Graphical Models (IT 4006)

Objective: Introduce probabilistic view on machine learning and discuss graphical models with Mathematical rigor and application in real problems. This course will make extensive use of probability, statistics, and optimization

Course outcome

At the end of this course, Students will be able to

- understand about probabilistic machine learning and get exposure to current cutting edge research.
- develop an in-depth understanding of probabilistic graphical models.
- describe and analyze properties of graphical models, and formulate suitable models for concrete estimation and learning tasks.

Probabilistic supervised learning and Probabilistic Unsupervised learning

Graphical Model representation

Bayesian and Markov networks, and dynamic Bayesian networks. Probabilistic inference algorithms, both exact and approximate; Sampling; and learning methods for both the parameters and the structure of graphical models.

Generative Adversarial Network (GAN)

Encoder-Decoder, Variational Autoencoder, GAN

Text Books

Reference

- Kevin Murphy, “Machine learning: a probabilistic perspective”, MIT Press, 2012.
- Daphne Koller and Nir Friedman, Probabilistic Graphical Models: Principles and Techniques
- Michael I. Jordan, An Introduction to Probabilistic Graphical Models, in preparation. Course2

HSMC

List of courses are:

- Constitution of India
- Professional Ethics
- Universal Human Values
- Environmental Studies
- Physical Education

Constitution of India (MS1102)

Objective: Students will be able to understand the Fundamental features of the Indian Constitution, Union Government, Rights and Duties, Statutory Institutions.

Course Outcome
Students will be able to:

- Understand Indian Constitution, its composition and functions, Union and state Government
- Understand Rights and Duties, Statutory Institutions etc

Introduction
Evolution of the Indian Constitution, Acts, Fundamental features of the Indian Constitution, Union, State and Local Government.

Rights and Duties
Fundamental Rights and Duties, Directive Principles, Relation between Federal and Provincial units: Union-State relations, Administrative, legislative& Financial, Inter-State Council, NITI Ayog, Finance Commission of India, Union List, State List, Concurrent List, Statutory Institutions: Elections-Election Commission of India, National Human Rights Commission, National Commission for Women

Reference

- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, New Delhi
- Subhash Kashyap, Our Parliament, National Book Trust, New Delhi
- Peu Ghosh, Indian Government &Politics, Prentice Hall of India, New Delhi

Universal Human Values (MS1103)

Objective: Students will be able to understand the human values.

Course Outcome
Students will be able to:

- Understand the importance of human values, family, society, nature etc.
- Develop commitment and courage to act.

Introduction
Development of a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence, Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence

Self Reflection
Right understanding Strengthening of self-reflection, Development of commitment and courage to act, Method to fulfill the human aspirations: understanding and living in harmony at various levels.

Reference

Professional Ethics (MS1104)

Objective: Students will be able to understand the awareness on Engineering Ethics and Human Values.

Course Outcome
Students will be able to:

- Understand social responsibility of an engineer etc.
- To appreciate ethical dilemma while discharging duties in professional life.

Values
Human Values Morals, Integrity, Work Ethics, Honesty, Courage, Empathy etc. Kohlberg's theory, Gilligan's theory, Models of Professional Roles.

Ethics
Codes of ethics, Challenger case study, Safety and Risk, The Three Mile Island And Chernobyl Case Studies, global issues, moral leadership

Reference

- Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.
- Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.
- Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
- Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
- John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 2003.

Environmental Studies (MS1107)

Objective: To make student learn the importance of environmental studies, different resources, ecosystem etc.

Course Outcome

Students will be able to

- Understand the Multidisciplinary nature of environmental studies.
- Structure and function of an ecosystem
- Environmental Pollution etc.

Nature of Environmental studies, Ecosystems

Definition, Scope and importance, Need for public awareness. Different resources, Concept of an ecosystem, Structure and its function, Food chains, Different eco systems, Biodiversity, Threats, In-situ and Ex-situ conservation of biodiversity.

Environmental Pollution & Field Work

Causes, effects and control measures of different pollution, Nuclear hazards, Pollution case studies, Disaster management, Water conservation, rain water harvesting, watershed management, Case studies on Environmental ethics, Climate change, global warming, Case studies. - Wasteland reclamation, Environment Protection Act, Water Act, Wildlife Protection Act, Visit to a local polluted site and Study of ecosystems.

References:

- Agarwal, K.C.2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
- BharuchaErach, The Biodiversity of India, Mapin Publishing Pvt.Ltd. , Ahmedabad
- Brunner R.C., 1989, Hazardous Waste Incineration, McGraw Hill Inc.
- Clark R.S., Marine Pollution, Clanderson Press Oxford (TB)
- Cunningham, W.P.Cooper, T.H.Gorhani, E &Hepworth, M.T.2001. Environmental Encyclopedia, Jaico Publ. House. Mumbai, 1196p
- Dc A.K., Environmental Chemistry, Wiley Eastern Ltd.
- Down to Earth, Centre for Science and Environment(R)
- Gleick, 11.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute. Oxford Univ. Press. 473

Physical Education (Sports) (MS1108)

Objective: To aware the students on the importance of physical education for a healthy life and train them on various sports, games, yoga, etc. for physical fitness.

Course Outcome

Students will be able to

- Understand the knowledge of various ways for maintaining both physical and mental wellness

Know your body

First Aid for basic medical conditions, CPR for emergency, Diabetic and Obesity condition of Indian and world, Importance of physical education.

Yoga and Meditation

Yoga for wellness and concentration, Meditation for wellness

Athletics and Aquatics

Rules, benefits and mastering of various track and field events such as Sprint, Marathon, Hurdles, Long Jump, High Jump, Javelin throw, Shot Put, Discus throw, etc.

Rules, benefits and mastering of various styles of swimming, butterfly, freestyle, backstroke, and breaststroke, Sports for physical fitness like Cricket, basketball, football, volleyball, etc.

References:

- Dr. V K Sharma, “Health and Physical Education”. New Sarasvati House Publishers.
- “Yoga: A Healthy Way of Living”. By National Council of Educational Research and Training.
- Mark Young. “The Complete Beginners Guide to Swimming”.
- Dr. Ashwini Bhardwaj. “A Complete Guide to Family Safety and First Aid”. GoodWill’s Publishers.

Optimization (IT 4007)

Objective: The course aims to introduce students to modern convex optimization and its applications in fields such as machine learning

Course outcome

At the end of this course, Students will be able to

- recognize and formulate convex optimization problems as they arise in practice.

Convex Analysis

Convex Sets, Convex Functions, Calculus of convex functions
Optimality of Convex Programs: 1st order nec. and suff. conditions, KKT conditions
Duality: Lagrange and Conic duality

Standard Convex Programs and Applications

Gradient descent, Stochastic gradient descent, Newton's methods, Interior Point method.Nonsmooth Problems: Subgradient descent..

Online convex optimizationNon-convex optimization

Adom and other variants.

Text Books

- S.Boyd and L.Vandenberghe. Convex Optimization. Cambridge University Press, 2004.

Reference

- R.T.Rockafellar. Convex Analysis. Princeton University Press, 1996.
- A.Nemirovski. Lectures On Modern Convex Optimization (2005). Available at
- www2.isye.gatech.edu/~nemirovs/Lect_ModConvOpt.pdf
- Y.Nesterov. Introductory Lectures on Convex Optimization: A Basic Course. Kluwer Academic Publishers, 2004

Robot Motion Control (IT 4020)

Objective: To be able to obtain a working mathematical model of a system and be able to do a time-domain and frequency-domain analyses of the model to predict the system's behavior.

Course outcome

At the end of this course, Students will be able to

- To design control systems that meet design specifications.
- To perform various analysis to predict the behavior of the system.

Introduction & Mathematical modeling

Motivation, examples of control systems, feed-back control systems, Mathematical modeling of: electrical systems, mechanical systems, electro-mechanical systems. Laplace transforms, transfer functions, electrical analogues of other dynamical systems. State-space modeling of dynamical systems. Block diagrams, block diagram reductions. Signal flow graph, Mason's gain formula. Linearity, time-invariance versus nonlinearity and time-variance. Linearization. Distributed parameter systems

Time response of dynamical systems, Stability & Feedback

Obtaining solutions from mathematical models. Poles and zeros and their effects on solutions. Step response of standard second order systems, time-domain specifications and their formulae, Definition of stability. Routh-Hurwitz test. Lyapunov theory, Basic idea of feedback control systems. Error analysis. P, PI, PD, PID controllers.

Design of controllers & Frequency domain analysis

The root-locus technique, steps in obtaining a root-locus. Design of controllers using root-locus Pole placement with state feedback, controllability. Pole placement with output feedback, observability, Luenberger observer. LQR control, Bode plot, Nyquist plot, Nyquist stability criterion, gain and phase margins, robustness.

Compensators

Design of Lead compensator, lag compensator, lead-lag / lag-lead compensators.

Text Books

- Franklin G. F., Powell J. D., Emami- Naeini A., Feedback Control of Dynamic Systems, Pearson, Upper Saddle River, New Jersey, 5th edition,2006.
- Ogata K., Modern Control Engineering, Prentice-Hall of India Pvt Ltd., New Delhi, 3rd edition,2000.
- Kuo B. C., Automatic Control Systems, Prentice-Hall of India Pvt Ltd., New Delhi, 6th edition,1991

Reference

Foundation of Robotics (IT 4030)

Objective: To build a strong mathematical foundation for modeling, analyzing, and designing robotic systems and to introduce advanced concepts in robot kinematics, dynamics, and control methodologies.

Course outcome

At the end of this course, Students will be able to

- Familiarize with sensory systems, information fusion techniques, and programming for robotic applications.
- Demonstrate proficiency in robotic kinematics, dynamics, and control for analyzing and designing robotic systems.
- Apply sensory information fusion and programming techniques for robotic perception and real-time applications.
- Engage in human-robot interaction and intelligent object manipulation tasks to address real-world challenges.

Fundamentals of Robotics

Introduction to the Profession, Mathematical Foundation for Spatial Rigid Body Representation, Spatial Orientation Transformation, Homogeneous Coordinate Transformation Matrix, Forward and Inverse Kinematics Problems, D-H Principle

Modeling and Analysis

Modeling Principle of a Cyber-Physical System , Manipulator Jacobian and Singularity, Robot Modeling Using Dynamics, Trajectory Planning

Control Systems for Robotics

Robot Control Principles, Master-Slave Control Architecture, PD-PID Control, Computed Torque/Model-Based Methodology, Nonlinear Control, Sensory Devices for Robots

Programming and Advanced Topics

Robot Programming, Basics of Human-Robot Interactions

Text Books

- Introduction to Robotics: Mechanics and Control- by John J. Craig
- Robotics: Modelling, Planning and Control by Bruno Siciliano, Lorenzo Sciavicco, Luigi Villani, and Giuseppe Oriolo
- Modern Robotics: Mechanics, Planning, and Control by Kevin M. Lynch and Frank C. Park

Reference

- A Mathematical Introduction to Robotic Manipulation by Richard M. Murray, Zexiang Li, and S. Shankar Sastry.
- Robotics, Vision and Control: Fundamental Algorithms in MATLAB®" by Peter Corke.

Advanced Graphics & Animation (IT 4040)

Objective: The course introduces techniques, algorithms and principles of interactive 3D computer graphics and animation

Course outcome

At the end of this course, Students will be able to

- identify and describe the fundamentals of 2D and 3D computer graphics,
- apply mathematics and physics in the design and development of graphics applications

Overview

2D and 3D transformations, Matrix representation of transformations, 2D viewing pipeline, 3D viewing pipeline, Introduction to OpenGL graphic programming

Object representation methods

Illumination and color models, Shading, Texture mapping, Graphics Acceleration algorithms such as Level-of-detail rendering, Image-based effects

Different generations of GPUs

Fixed & Programmable-function graphics pipeline, Graphics programming using CUDA, Principles of Animation, Traditional animation method, Key-frame animation, Morphing

Advanced topics in Animation

Facial Animation, Modeling & Animating Human Figure, Physically-based Animation; Group assignments on implementation of a Graphics & Animation Application using open-source toolkits/ libraries such as OpenGL, WebGL, CUDA or packages such as Maya etc.

Text Books

- Rick Parent, “Computer Animation: Algorithms & Techniques”, Morgan Kaufmann Pub.
- Tomas Akenine-Möller and Eric Haines Naty Hoffman, “Real-Time Rendering, 2nd Ed.”, A.K. Peters.
- D. Hearn & M.P. Baker, “Computer Graphics with OpenGL”, 4th Ed., Pearson Education.
- Francis S Hill Jr., Stephen M Kelley, “Computer Graphics Using OpenGL”, Prentice Hall of India.
- NVidia CUDA Repository, URL: http://developer.nvidia.com/category/zone/cuda-zone

Reference

Virtual Reality (IT 4041)

Objective: To promote the understanding of this technology, underlying principles, its potential and limits and to learn about the criteria for defining useful applications

Course outcome

At the end of this course, Students will be able to

- learn a ton about Virtual and Augmented Reality,
- get familiar with the latest technology, techniques and software, and build an application during the course

Introduction

Components of a VR system, 3D User Interface Input and Output devices, 3D viewing, Designing & Building VR Systems, Introduction to Augmented Reality (AR)

VR Modeling

Geometric modeling, Kinematic, Physical and Behavior modeling; Selection and Manipulation during 3D Interaction

Travel and Wayfinding in Virtual Environments

Strategies for Designing and Developing 3D UIs, Evaluation of 3D User Interfaces, Traditional and Emerging VR/AR applications

Human Factors in Virtual Reality

Case study on Construction of Geographic Virtual World. Group assignments on implementation of a Virtual/ Augmented Reality Application using open-source toolkits/ libraries such as OpenSceneGraph, Vega, VRML etc

Text Books

- G.C. Burdea & P. Coiffet, “Virtual reality Technology, Second Ed.”, Wiley-India.
- GJ Kim, “Designing VR Systems: The Structured Approach”, Springer.
- D.A. Bowman et al., “3D User Interfaces: Theory and Practice”, Addison Wesley.
- John Vince, “Virtual Reality Systems”, Pearson Ed.
- Rick Parent, “Computer Animation: Algorithms & Techniques”, Morgan Kaufmann.

Reference

Data Analytics (IT 4008)

Objective: The course discusses the methods & algorithms of data analysis and its related issues

Course outcome

At the end of this course, Students will be able to

- get exposure of various algorithms to be used in different application domain for data analysis and its practical implementations

Introduction

Fundamentals of data mining, Data Mining Functionalities, Classification of Data Mining systems, Major issues in Data Mining, Preprocessing the Data (Data Cleaning, Integration, Transformation & Reduction)Mining Association Rules: Association Rule Mining, Mining Single-Dimensional Boolean Association Rules from Transactional Databases, APRIORI, Variations of APRIORI (Sampling, Hash Based, Partitioning, Transaction Reduction), Frequent Pattern Growth, Mining Multilevel Association Rules from Transaction Databases, Mining Multidimensional Association Rules, Concept of LIFT, Clustering of Association rules

Classification and Prediction

Classification by Decision Tree Induction, Bayesian Classification, Classification by Back propagation, Classification Based on concepts from association Rule Mining, SVM, Prediction, and Classifier Accuracy

Clustering

Data types in cluster analysis, Categories of clustering methods, partitioning methods- K-Means, PAM, CLARA, CLARANS, KNN. Hierarchical Clustering- Agglomerative and Divisive Clustering, BIRCH and Chameleon, Density Based methods-DBSCAN, CURE, OPTICS, Grid Based Methods- STING, Wave Cluster, COBWEB, Outlier Analysis.

Text Books

Reference

- Jiawei Han MichelineKamberJian Pei “Data Mining: Concepts and Techniques” 3rd Edition, 2011
- Hadzic F., Tan H. & Dillon T. S. “Mining data with Complex Structures” Springer, 2011
- Yates R. B. and Neto B. R. “Modern Information Retrieval ” Pearson Education, 2005

Software Design and Architecture (IT 4400)

Objective: To provide students with the background to design, implement, and use mid size and large software systems

Course outcome

At the end of this course, Students will be able to

- understand the objectives of Software Architectural design and
- learn various Software Architecture prevalent wrt MVC , SOA etc

Introduction

Design objectives, purpose and approaches, Functional Independence with Coupling and Cohesion. Overview of OO Design: Class Diagrams Object Diagrams. Sequence and Collaboration Diagrams, Static and dynamic modeling approaches

Software Design Principles

Role of Modeling and Design, Design Metrics, OO Software Design. Design Principles with applications. . Iterative Refinement Behavior, Iterative Refinement Minimalism. Mobile Software and Design: Characteristics and Requirements, Mobile Interaction designs, UX design

Design Patterns and Architectural consideration

Recent Trends in Software Design, GoF and evolution of Design Patterns

Pattern based Design

Creational Design, Structural Design, Behavioral Design Patterns. Example, Architecture Types and Representation : Role of Software Architecture, Business Architecture, Solutions Architecture & Enterprise Architecture. Architecture for Web enabled applications. Separation of Concerns, Developing Application Architecture with GUI and Database connectivity. Database Design and Data Centric Architectures Architectural Implementations : MVC Architecture and Separation of Concerns, SOA and Web Services, RESTFul services and API. Advances in Software Architecture.Recent Trends in Software Architecture: Cloud Based Architecture, Service Oriented Architecture etc..

Text Books

- G. Booch, Object-Oriented Analysis and Design with Applications 2nd Ed.PHI, New Delhi, 1993.
- Design Patterns by R Johnson, John Vlissides, Richard Helm, and Erich Gamma.
- Software Architecture: Foundations, Theory, and Practice by Richard N. Taylor et al.(John Wiley and Sons).

Reference

- F Buschmann, Kelvin Henney& Douglas Schimdt, “Pattern-Oriented Software Architecture - A System of Patterns”, Volume 1, Wiley,2007.
- F Buschmann, K Henney & D Schimdt, “Pattern-Oriented Software Architecture – Pattern for Concurrent and Networked Objects”, Volume 2 ,Wiley, 2000

Software Requirements and Estimation (IT 4401)

Objective: Execute a complete requirements negotiation process, Perform a comprehensive feasibility analysis, Lead a software project planning process, Apply the principles and processes of software engineering project enactment

Course outcome

At the end of this course, Students will be able to

- Gain Knowledge about software requirements and will
- Analyze requirement elicitation techniques and prototyping

Software Requirements

Essential Software Requirement Good practices for requirement engineering Improving requirements processes Software Requirements and Risk Management

Software Requirements Engineering

Requirements elicitation Requirement analysis documentation, review, elicitation techniques, analysis models, software quality ttributes Risk reduction through prototyping, setting requirements priorities, verifying requirements quality, software requirements modeling Use case modelling, Analysis model, dataflow diagrams, state transition diagram, class diagram, object analysis, problem frames,

Design Patterns and Architectural consideration

Requirements management principles and practices Requirement attributes, change management process Requirement traceability matrix Links in requirements chain Requirement management tool,benefits of requirement management tools, commercial requirement management tools Rational Requisite pro Caliber-RM, Implementing requirement management automation

Software Estimation

Components of software estimation, software estimation models, Problems associated with estimation, Key project factors that influence estimation Size estimation- two views of sizing, Function point analysis, Mark II FPA, full function point, LOC estimation, conversions between size measures. What is productivity, estimation factors, approaches to effort and schedule estimation COCOMO II, Putnam estimation model Algorithmic models, cost estimation, software estimation tools, desirable features of software estimation tools IFPUG, USC's COCOMO II, SLIM tools.

Text Books

- Swapna Kishore, Rajesh Naik, Software Requirements and Estimation,1stEdition, Tata McGraw Hill, 2001.

Reference

- Karl E. Weigers, Software Requirements, 2ndEdition, Microsoft Press, 2003.
- Ian K. Bray, An Introduction to Requirements Engineering, Addison Wesley, 2002
- Ian F. Alexander, Richard Stevens, Writing better requirements, Addison-Wesley, 2002

Software Testing and Quality Management (IT 4500)

Objective: Develop methods and procedures for software development that can scale up for large systems and that can be used to consistently produce high-quality software.

Course outcome

At the end of this course, Students will be able to

- Software "V" model of testing Static and dynamic testing techniques
- Software testing metrics Process management etc

Software Testing

Bug, Reasons of Bugs, Cost of Bugs, Software Tester Task. Introduction to Software Development Models Software Testing: Testing axioms, Terms & Definitions Testing Fundamentals: Types, Black Box, White Box, Static & Dynamic Testing. Static Black Box Testing. Dynamic Black Box Testing: Test to Pass & Test to Fail, Equivalence Partitioning, Data Testing, State Testing, , Other Black Box Testing Techniques

Static White Box Testing

Formal & Peer Reviews, Coding Standards and Guidelines. Review Check List Dynamic White Box Testing: Comparison with Debugging, Testing Pieces: Unit & Integration Testing Configuration Testing: Deciding Hardware Configurations. Compatibility Testing: Overview, Backward and Forward Compatibility. Testing Multiple versions. Data Sharing Compatibility Effective UI, Testing for Disabled. Data Coverage & Code Coverage

Documentation Testing

Documentation Testing. Security Testing: Threat Modelling, Buffer Overrun, Safe String Functions, Computer Forensics Web Site Testing, Black Box Testing: Text, Hyperlinks, graphics, Forms. Gray Box Testing & White Box Testing, Configuration and Compatibility Testing System Testing Recovery Testing Security Testing Stress Testing Performance

Planning Testing

Goals, Test phases, Strategy, Resource Requirements, Schedule, Test Cases, Bug Reporting, Metrics. Test Cases: Test Case Planning, Design, Cases, Procedures, Organization and Tracking. Bug Life Cycle and Tracking System. Testing, QA and QC Quality Management Quality Planning Process Quality Assurance Process Quality Control process Organisational Structures: CMM Capability Maturity Model, ISO 9000

Text Books

- KshirasagarNaik and PriyadarshiTripathy, Software Testing and Quality Assurance: Theory and Practice, John Wiley & Sons, Inc.

Reference

- William Perry, "Effective Methods for Software Testing", John Wiley & Sons, New York, 1995. Louise Tamres, "Software Testing", Pearson Education Asia, 2002
- Robert V. Binder, "Testing Object-Oriented Systems-Models, Patterns and Tools", Addison Wesley, 1999. CemKaner, Jack Falk, Nguyen Quoc, "Testing Computer Software", Second Edition, Van Nostrand Reinhold, New York, 1993.

Data Visualization (IT 4601)

Objective: This course covers graphical representation of information and data for information technology.

Course Outcomes

Students will be able to:

- fundamentals and be able to apply these knowledge in practical problems..

Information Visualization

Visual Display of Quantitative Information, Power of Representation, Data-Ink and Graphical Redesign, Data Density, Interactive Data Visualization for the Web. Scalable, Versatile and Simple Constrained Graph Layout, Visualization of Adjacency Relations in Hierarchical Data

Graphical Models Theory, Experimentation and the Application to the Development of, Layering Interactive Dynamics for Visual Analysis, Animated Transitions in Statistical Data Graphics Effectiveness of Animation in Trend Visualization

Cartogram

Value-by-Area Mapping. Cartography Thematic Map Design and Adaptive Composite Map Projections. Information Visualization for Search Interfaces, Information Visualization for Text Analysis, Supporting Asynchronous Collaborative Information Visualization, Designing for Social Data Analysis

Tool based Visualization of different data

Visual analytics, Dashboard development, Exploratory visualization

Text Book

- The Visual Display of Quantitative Information (2nd Edition). E. Tufte. Graphics Press, 2001.
- Envisioning Information, E. Tufte. Graphics Press, 1990

References

Big Data Analytics (IT 4250)

Objective: This course covers the concept of big data analytics, algorithms, applications and frameworks

Course Outcomes

Students will be able to:

- study of big data analytics and
- be able to apply in practical problems.

Introduction to Big Data and its importance

3 Vs and more, Big data analytics, Big data applications. Hadoop & Hadoop EcoSystem, Moving Data in and out of Hadoop, Inputs and outputs of MapReduce, Hadoop Architecture, HDFS, Common Hadoop Shell commands, NameNode, Secondary NameNode, and DataNode

Maps

Hadoop Map Reduce paradigm, Map and Reduce tasks, Job, Task trackers , Algorithms using MapReduce, Examples of Map Reduce (Word count problem, Matrix-Vector vector multiplication), YARN & Zookeeper, Hadoop Cluster Setup & Hadoop Configuration, and HDFS Administration: Monitoring & Maintenance

Hive Architecture, Comparison with Traditional Database, HiveQL - Querying Data - Sorting And Aggregating, Map Reduce Scripts, Joins & Subqueries, HBase Concepts; Advanced Usage, Schema Design & Indexing - PIG, Zookeeper

Spark

RDD in Spark, Data Frames & Spark SQL, Spark Streaming, MongoDB, NoSQL

Text Book

- Chris Eaton, Dirk Deroos et al. , “Understanding Big data ”, McGraw Hill, 2012
- Boris Lublinsky, Kevin t. Smith, Alexey Yakubovich, “Professional Hadoop Solutions," Wiley, ISBN: 9788126551071, 2015

References

- Tom White, “HADOOP: The Definitive Guide”, O'Reilly 2012
- Aven Jeffrey, Data Analytics with Spark Using Python | Big Data | First Edition | Pearson Paperback, November 2018

Parallel and Distributed Computing (IT 4522)

Objective: To introduce various Parallel and Distributed hardware architectures and programming models

Course Outcome

Students will be able to:

- Understand the basics of various parallel and distributed computing platforms
- Identify the models and frameworks best suited to various workloads.
- Provide solutions to parallel and distributed computing problems.

Introduction to PDC

Latency vs Bandwidth, Applications and Challenges, Types of architecture, Flynn's taxonomy, Basic concepts: cores, nodes, threads, processes, speedup, efficiency, overhead, strong and weak scaling (Amdahl's law, Gustafson's law), Cache, Principle of Locality, Programming Models

Distributed Computing

Distributed Memory, Message Passing Interface, Asynchronous/Synchronous computation/communication, concurrency control, fault tolerance, Distributed Programming with Open MPI

Parallel Computing

Shared memory, data & task parallelism, Synchronization, Concurrent Data Structures, Shared Memory Programming with available APIs: PThreads, OpenMP, TBB

GPU Programming

GPU Architecture, Programming Models: CUDA/OpenCL, Basic Concepts: Threads, Blocks, Grids, GPU memory hierarchy, Thread Scheduling, Warps and Control divergence, Memory Coalescing, Programming with CUDA, Using: CuBLAS, CuFFT.

Textbooks:

- "Introduction to Parallel Computing", Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, Addison-Wesley, Second Edition.
- "Programming Massively Parallel Processors: A Hands-on Approach", Wen-Mei W Hwu, David B Kirk, Morgann Kaufmann, Third edition.

References:

- "The Art of Multiprocessor Programming", Maurice Herlihy and Nir Shavit, Morgan Kaufmann Publishers.
- "Principles of Parallel Programming", Calvin Lin and Larry Snyder, Addison-Wesley.
- "Introduction to Parallel Programming", Peter S. Pacheo, Morgan Kaufmann Publishers.

Introduction to Cryptography (IT 4009)

Objective: : The objective of this course is to impart knowledge of the basic principles and concepts of modern cryptography

Course Outcome

Students will be able to:

- Understand modern cryptography which shall be self- sufficient for any second course in the area of security

Introduction

Modern cryptography, Historical ciphers and their cryptanalysis, heuristic principles of defining security, Perfectly-Secret Encryption: Definitions, the one-time pad; proven limitations, Private-Key (Symmetric) Encryption: Computational security, Defining secure, encryption, Constructing secure encryption; pseudo randomness, Stronger security notions, Constructing CPA-secure encryption, Modes of operation; Security of CTR with n − k bit counter for messages to size 2k blocks with proof to the LR definition, CCA.

Message Authentication Codes

Message integrity, Definition of security, Constructions from pseudorandom functions, CBC-MAC, Authenticated encryption. Collision-Resistant Hash Functions: Definitions, The Merkle-Damgard transform, HMAC, Birthday attacks, The Random oracle model, Password hashing, Constructions of Pseudorandom Permutations (Block Ciphers) in Practice, Substitution-permutation and Feistel networks, DES and attacks on reduced-round versions, double-DES and triple-DES, AES, Hash functions from block ciphers.

Parallel Computing

Number Theory: Preliminaries and basic group theory, Primes, factoring and RSA, Cryptographic assumptions in cyclic groups, Collision resistant hash functions from discrete log, Public-Key (Asymmetric) Cryptography: Introduction and motivation, Diffie-Hellman key exchange

Public-Key (Asymmetric) Encryption

Model and definitions, Hybrid encryption and KEM/DEM, El Gamal, RSA: textbook encryption, attacks on textbook RSA, padded RSA; CCA-secure RSA KEM.
Digital Signatures: Definition and applications, Hash and sign, RSA signatures: textbook RSA, hashed RSA, security with ROM, Certificates and public-key infrastructures.

Textbooks

References:

- Jonathan Katz and Yehuda Lindell, Introduction to Modern Cryptography, second edition 2014, CRC Press.
- Cryptography: Theory and Practice by Douglas Stinson, Third edition, CRC Press.
- Handbook of Applied Cryptography by Alfred Menezes, Paul Oorschot and Scott Vanstone. Available Online.
- Foundations of Cryptography by Oded Goldreich. Available Online.

Networking Concepts (IT 4010)

Objective: This course introduces the fundamental concepts of computer networks and different protocols used to connect and transfer data

Course Outcome

Students will be able to:

- realize the network communication, practical experience of networking and
- usage of specific protocols in various requirements.

Introduction

Network vs. distributed system, Point to point Network vs. Multipoint Network, Classify networks, Network performance measures, OSI Reference Model, TCP/IP Reference Model, Multiplexing, circuit switching, message switching, packet switching. Physical Layer: baud {modulation rate}, data rate {capacity}, bandwidth, Nyquist Theorem, Shannon's Result, Data Encoding Techniques, digital data, analog signals, digital data, digital signals, Transmission Media

Data Link Layer

Transmission Errors, error detection and error correction, Hamming Codes, Parity Checks, Checksum, CRC, Framing, bit stuffing, byte stuffing, Data Link protocols such as PPP, BYSYNC, DDCMP, HDLC, Stop-and-Wait, sliding window protocols, MAC Layer Protocols such as Aloha (Pure Aloha & Slotted Aloha), Persistent and Non persistent CSMA, CSMA/CD, LAN Standards, 802.1 to 802.5 and 802.11.

Network Layer

IPv4 details, Routing Protocols, Distance Vector Routing (RIP), Link State Routing (OSPF), Border Gateway Protocols (BGPv4), Network Layer Utility Protocols like ICMP, Ping, ARP, RARP, DHCP, Traceroute, IPv6 details Transport Layer: Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End to End Issues, Connection Establishment and Termination of TCP, TCP Sliding Windows

Congestion Control

TCP Congestion Control, AIMD, Slow Start, Fast Transmit and fast recovery, Congestion Avoidance Mechanism DECbit and Random Early Detection (RED). Application Protocols: HTTP, DNS, DHCP, SMTP, IMAP, RTP

Textbooks

- Computer networks – Larry L. Peterson and Bruce S. Davie.
- Computer Networks – Andrew S. Tenenbaum

References:

- Data and Computer Communications – William Stallings
- Internetworking with TCP/IP – Douglas E. Comer Vol. II and I.
- Computer Networks and Internet – Douglus E. Coumer
- Unix Network Programming – Richards Steavens
- Cryptography and Network security – William Stallings

Principles of Wireless Communication (IT 4700)

Objective: To enable the student to synthesis and analyze wireless and mobile cellular communication systems over a stochastic fading channel.

Course Outcome

Students will be able to:

- able to analyze wireless and mobile cellular systems and
- design wireless and mobile cellular systems..

Digital communication systems

Baseband and Bandpass

Information theory and error control codes

Information theory and error control codes.

Physical modeling for wireless channels

Free space fixed transmitting and receive antennas, free space moving antenna, reflecting wall fixed antenna, reflecting wall moving antenna, power decay with distance and shadowing, two-ray model, etc., Link budget design using path-loss model, Outdoor and indoor propagation models, Small scale multipath propagation, Delay spread, Coherence bandwidth, Doppler spread & Coherence time, Flat fading, Frequency selective fading, Fast fading, Slow fading

Diversity concept, Non-coherent and coherent reception

Time diversity, Repetition coding, Frequency diversity, Receiver diversity (SC, EGC and MRC), Multiple receive antenna system model and its error performance analysis, Transmit diversity, Channel estimation for multi-antenna system, Diversity order analysis

Textbooks

- T. S. Rappaport, Wireless Communications, 2nd ed. Principles and Practice, Pearson Education India, 2009.
- D. Tse and P. Viswanath, Fundamentals of Wireless Communications, Cambridge University Press, 2005

References

- B. Carlson, P. B. Crilly, and J. C. Rutledge, Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 4th ed. McGraw Hill, 2002.
- L. Song and J. Shen, Evolved Cellular Networks planning and optimization for UMTS and LTE,
- Y.-W. P. Hong, W.-J. Huang, C.-C. Jay Kuo, Cooperative Communications and Networking:Technologies and System Design, 1st ed. Springer, 2010.

Cloud and Edge Computing (IT 4701)

Objective: To introduce concepts of Cloud and Edge Computing.

Course Outcome

Students will be able to:

- approach designing of parallel computation based better
- not only know the theoretical concepts but also practical skills to implement the solutions

Introduction to Cloud Computing

Introduction to Cloud Computing, Recent Trends in Computing Cloud Computing, Evolution of cloud computing.

Cloud Computing Architecture

Service Management in Cloud Computing Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service(SaaS), Data Management in Cloud Computing, Resource Management in Cloud Computing, Cloud Implementation

Open Source and Commercial Clouds

Cloud Simulator, Research trend in Cloud Computing, Fog Computing, VM Resource Allocation, Management and Monitoring, Introduction to Edge Computing, the Cloud Computing analytics pipeline, Coordination of Cloud Services.

Serverless Computing and FaaS Model

Cloud-Fog-Edge enabled Analytics, Cloud Security, Case Studies and Recent Advancements

Textbooks

References

- Cloud Computing: Principles and Paradigms, Editors: RajkumarBuyya, James Broberg, Andrzej M. Goscinski, Wiley,2011.
- Enterprise Cloud Computing - Technology, Architecture, Applications, GautamShroff, Cambridge University Press, 2010.
- Cloud Computing Bible, Barrie Sosinsky, Wiley-India, 2010.
- Cloud Security: A Comprehensive Guide to Secure Cloud Computing, Ronald L. Krutz, Russell Dean Vines, Wiley- India, 2010.
- Cloud Computing: Principles, Systems and Applications, Editors: Nikos Antonopoulos, Lee Gillam, Springer, 2012

Embedded System and IoT (IT 4800)

Objective: To introduce concepts of Cloud and Edge Computing.

Course Outcome

Students will be able to:

- approach designing of parallel computation based better
- not only know the theoretical concepts but also practical skills to implement the solutions

Embedded, Cyber-Physical Systems and IoT

Introduction, application areas, examples, Common characteristics, Challenges and design flows, Modeling of Embedded and Cyber Physical Systems - Requirements, models of computation, Finite State Machines, Timed Automata, State Charts, Modeling of Hierarchy; Data flow modeling , Discrete Event Modeling , Continuous and Discrete time system concepts.

Design

Choosing the components HW platforms Processors, Sensors, Actuators; SW stack – RTOS, Scheduling Real Time control tasks, IoT Fundamentals - Devices, Gateway; Elements of IoT - IoT Functional blocks, IoT Communication Modules and API

Basics of Networking

Machine-to-Machine interaction, IoT Communication Protocols MQTT, ZigBee, Bluetooth, CoAP, UDP, TCP

Concept of Cloud Computing

Everything as a Service (XaaS), Role of Cloud; Software Components - Programming API's; IoT Application Development - Solution Framework for IoT. Advanced topics - Data Analytics for IoT, Fault Tolerance in IoT based Systems; IoT Security.

Textbooks

References

- Peter Mardwel, Embedded System Foundations of Cyber Physical Systems Springer 2nd Edition.
- E. A. Lee, Sanjit Seshia Introduction to Embedded Systems – A Cyber–Physical Systems Approach.
- Rajeev Alur, Principles of Cyber-Physical Systems.
- Pethuru Raj and Anupama C. Raman (CRC Press) , The Internet of Things : Enabling Technologies, Platforms and Use Cases.
- Arshdeep Bagha and Vijay Madisetti Internet of Things: A Hands-on Approach

Information Security laws and Regulation (IT 4900)

Objective: The purpose of this course is to develop the foundation of Information security governance, implementation of cyber security practices in the organization.

Course Outcome

Students will be able to:

- Create information security policies;
- systematically decode the element of cyber crime in order to understand the cyber attack execution strategies.
- learn the component of information security programmes and how to ensure compliance of international frameworks

Information security laws, regulation and standards

Information Security programmes and practices, Analysis of cyber crime based on parameter to develop attack vector pathways. Information security strategies for effective information security implementation. Information security requirements and classification. Overview of information security metrics used in organizational need for information security. Use of CVE database, Overview of IS027001. IT Act,2000.

Information security Regulation

Components of CII, Threat Landscape, Critical Digital Assets, Regulation NERC 5.71, Framework implementation guidance. Information Security Regulation for Payment Card Industry, Design consideration based on Network flow and Data flow requirements. The regulatory need for operators, merchants and its implementation,Best practices implementation, Compliance requirements.

Data protection laws and regulations

GDPR, Privacy impact analysis, Implement, Investigation life cycle

Textbook

- P.W. Singer and Allan Friedman, Cybersecurity and Cyberwar: What Everyone Needs to Know (2014, Oxford University Press) , Nina Godbole, Cyber Security(Wiley India

References

- Guide to cyber laws : information technology act-2000, e-commerce, data protection & the internet by Ryder Rodney D.
- A Guide to Information Technology : Cyber Laws & E-commerce By: Ahmed Syed, Shakil ; Raheja, Rajiv.
- Legal dimensions of cyberspace By: edited by S. K. Verma ; Raman Mittal.

Network Security (IT 4901)

Objective: This course provides an essential study of network security issues and methods in networking systems.

Course Outcome

Students will be able to:

- get knowledge about the network security
- implementation and requirements of network security

Introduction to Network security

Model for Network security, Model for Network access security, Real-time Communication Security: Introduction to TCP/IP protocol stack, Implementation layers for security protocols and implications, IPsec: AH and ESP, IPsec: IKE. Media- Based-Vulnerabilities, Network Device Vulnerabilities, Back Doors, Denial of Service (DoS), Spoofing, Man-in-the-Middle, and replay, Protocol -Based Attacks, DNS Attack, DNS Spoofing, DNS Poisoning, ARP Poisoning, TCP/IP Hijacking, Virtual LAN (VLAN), Demilitarization Zone (DMZ) , Network Access Control (NAC), Proxy Server , Honey Pot , Network Intrusion Detection Systems (NIDS) and Host Network Intrusion Prevention Systems Protocol Analyzers, Internet Content Filters, Integrated Network Security Hardware

Authentication

Kerberos, X.509 Authentication Service, Scanning: Port Scanning, Port Knocking- Advantages, Disadvantages. Peer to Peer security. Electronic Mail Security: Distribution lists, Establishing keys, Privacy, source authentication, message integrity, non-repudiation, proof of submission, proof of delivery, message flow confidentiality, anonymity, Pretty Good Privacy (PGP).

Firewalls and Web Security

Packet filters, Application level gateways, Encrypted tunnels, Cookies. Assignments on latest network security techniques, Security applications in wireless sensor network and wireless Communication networks

Textbook

- William Stallings, “Cryptography and Network Security – Principles and Practices”, Prentice Hall of India, Third Edition, 2003.

References

- Cisco: Fundamentals of Network Security Companion Guide (Cisco Networking Academy Program).
- Saadat Malik, Saadat Malik. “Network Security Principles and Practices (CCIE Professional Development)”. Pearson E ducation. 2002. (ISBN: 1587050250) .
- Mark Ciampa “Security + Guide to Network Security Fundamentals/Edition 3” Cengage Learning publisher, ISBN-10: 1428340661, ISBN-13: 978-1428340664

Cyber Physical System Security (IT 4950)

Objective: This course will cover the CPS basics, Vulnerabilities, Risk and security along with legal perspective.

Course Outcome

Students will be able to:

- understand the CPS basics, implementation, possible vulnerabilities, impacts and solutions.
- understand the various legal and privacy aspects and Risk Management in CPS.

Introduction to Industrial Control Systems and Operations

Industrial Network Protocols, Cyber Physical System Modeling, Plant Models, Feed Back Control Model, and Anomaly Detection Models

CPSS

Concepts and Principles, Securing Industrial Control Systems, Advanced Cyber-Physical Systems Security Concepts, Cyber threat model - Types of Cyber Threats to Industrial Critical System Modeled in a 3 dimensional Attack Space.

Critical Infrastructures

Power Grid, Railways Systems, Transportation Systems, Water/Sewage Systems and their automation architecture, Vulnerabilities, and Past Cases of Cyber Security Compromises and Trends.Stuxnet Case Study, SCADA Based Control, Sensors (IEDs, PLCs), field network and its protocols (profibus, DNP3 etc), ICS/SCADA Security, IoT Security, Legal and Privacy Aspects, CPSS: Risk Management

Textbook

References

- Handbook on Securing Cyber-Physical Critical Infrastructure, Sajal K. Das, Krishna Kant, Nan Zhang, Morgan Kaufmann (Elsevier), ISBN 978-0-12-415815-3, Publication: 2012.

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M.TECH- AS

Applicable with effect from 2023 admitted batch and onwards

OMICS (AS 4001)

Objective: The aim is to provide the fundamental knowledge of Molecular biology, Biochemistry, Genomics and Proteomics.

Course Outcome

Students will be able to:

- understand a basic understanding of Advanced Biology.
- Endow with knowledge about the different biological processes and the biomolecules involved.
- Will learn the principles of different laboratory techniques from Proteomics and Genomics which will be implemented in the practical classes.

Genomics

Central dogma of molecular biology, Gene structure and its expression, Concepts of gene regulation, Genetic codon, Restriction enzymes and mapping, Site directed Mutagenesis, Major DNA sequencing techniques

Transcriptomics

Transcription and post-transcriptional modifications of RNA, Tools for read mapping, identification of splicing variants and differential expression analysis, characteristics and analysis of small and long non-coding RNA, Gene Ontology.

Proteomics

Translation and post-translational modifications of proteins, Basic tools and techniques for protein expression, separation and analysis, Cloning and expression plasmid, Recombinant DNA technology, Software packages and available tools for proteomics.

Analytical techniques used in Genomics, Transcriptomics and Proteomics

Agarose Gel electrophoresis, SDS-PAGE, 2D-PAGE, Blotting Techniques, EMSA, PCR, RT-PCR, Immunoprecipitation, Chip-seq, RNA-seq, DNA Microarray, ELISA, Mass spectrometry, Protein microarray.

Textbook

- Bioinformatics for omics data: methods and protocols (2011), Mayer, B., New York: Humana Press. ISBN 978-1617790270
- OMICS: Applications in Biomedical, Agricultural, and Environmental Sciences (2013), Barh D., Zambare V., Azevedo V. CRC Press. Taylor and Francis Group. ISBN 9781138074750

References

- Applications of Advances Omics Technologies: from Genes to Metabolites (2014), Wilson and Wilsons. Elsevier. ISBN: 9780444626509
- Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods (2015), Bagchi D., Swaroop A., Bagchi M. Wiley Blackwell. ISBN:9781118930427
- Principles of Proteomics (2013), Twyman, R., Garland Science,

Data Analytics Fundamental for Biology (AS 4002)

Objective: To expose the students with the advanced techniques of Probability and statistics applied to biological data.

Course Outcome

Students will be able to:

- learn modern statistical techniques (sampling, hypothesis tests, correlation, regression analysis, etc.) to analyze different kinds of data associated with Health Sciences
- to build their skill to become practicing health professionals

Basic Concepts of Probability

Review of the basic concepts of Probability (upto Bayes Theorem) and Statistics (Central tendencies and standard deviations)

Probability Distribution functions

Binomial, Poissonand Normal distributions, Central Limit The oremandit's applications.

Sampling

Sampling distribution, Estimation, Interval estimation, Confidence interval, Test of hypotheses, Z-test, t-test, the chi-square test, F-test and ANOVA test.

Correlation and Regression analyses

Correlation Coefficients, Least square method and curve fittings, Single and multi-variable regression.

Text Book

- Biostatistics-A Foundation for Analysis in the Health Sciences'by Wayne E. Daniel and Chad L.Gross.

References

- Fundamental of Biostatistics by Bernard Rosner.

Scripting and Computer Environments (AS 4003)

Objective: To expose the students to scripting languages of relevance to Bioinformatics.

Course Outcome
Students will be able to:

- Learn scripting languages Perl, Python and R to accomplish tasks required for general purposes in Bioinformatics.

Basics
Function, Modules, Collections, Control Statements, File Handling, Pattern Matching

Sequence
Sequence Objects, Sequence Handling, Search Tools, Online Databases, Numpy, Pandas and Matplotlib

Handling PDBs
Local and Global Alignments, Dynamic Programming: Smith & Waterman, Needleman & Wunsch Algorithm

Multiple Sequence Alignment
Concepts & Implementations, Amino Acid Substitution Matrices PAM & BLOSUM Derivation of Dayhoff Matrices, Profiles & Motifs General Tools, Techniques & Resources Clustal W, BLAST and FASTA

Text Book:

- Learning Perl Randal Schwartz, Tom Phoenix, driandfoy (O'Reilly)

References:

- Molecular Modeling: Principles and Applications (2ndEdition) Andrew R.Leach (PrenticeHall)
- Proteins:Structures and Molecular Properties Thomas E.Creighton(Freeman)
- Fast Lane to Python http://heather.cs.ucdavis.edu/~matloff//Python/PLN/FastLanePython.pdf

Data Structure and Algorithms (AS 4004)

Objective: To impart the knowledge of basic programming and elementary data structure.

Course Outcome
Students will be able to:

- Understand data structures and algorithms
- create logical solutions to solve them.

Basics
Flowcharts, Algorithms, Data Structures – Definition, Linear Data Structures, Non-Linear Data Structures Python Specific Data Structures: List, Tuples, Set, Dictionaries, Comprehensions and its Types, Strings, slicing.

Arrays
Types of Arrays, Operations on Arrays, Arrays vs List. Searching -Linear Search and Binary Search. Sorting - Bubble Sort, Selection Sort, Insertion Sort, Merge Sort, Quick Sort, Implementation of Singly Linked Lists, Doubly Linked Lists, Circular Linked Lists.

Stacks
Overview of Stack, Implementation of Stack (List & Linked list), Applications of Stack Queues: Overview of Queue, Implementation of Queue (List & Linked list), Applications of Queues, Priority Queues.

Graphs -Introduction, Directed vs Undirected Graphs, Weighted vs Unweighted Graphs, Representations, Breadth First Search, Depth First Search. Trees - Overview of Trees, Tree Terminology, Binary Trees: Introduction, Implementation, Applications. Tree Traversals, Binary Search Trees: Introduction, Implementation.

References:

- Think Python(2e), Allen Downey, O'Reilly
- Introduction to Algorithms, Thomas H. Cormen, Charles E. Leiserson, Ronald. L. Rivest, Clifford Stein.
- Data Structures Using C and C++, Yedidyah Langsam, Moshe J. Augenstein, and Aaron M. Tenenbaum.

Data Engineering for Molecular Structure Prediction (AS4101)

Objective: To provide knowledge and exposure on Molecular Structure Prediction for use in control of disease (pathophysiological condition of health) through application.

Course Outcome
Students will be able to:

- Learn tools and techniques for biomolecular structure predictions.
- Get well versed with the principle of predicting authentic structures of biomolecules
- Gain fundamental knowledge of applications of systems engineering principles

Basic structural principles
Building blocks of life, Chemical properties of polypeptides, Intermolecular forces and Types, Entropy and temperature, Protein folding, Levinthal Paradox, Levels, Quaternary structure, Motifs, folds and domains of Protein structure: Hydrophobic and hydrophilic regions, Ramachandran Plot, Alpha-helix, Beta-sheets, Loops.

Structure determination & prediction primer
X-Ray crystallography & NMR; Other Structure determination methods, Fundamental of Protein structure prediction, Impediments, Secondary structure prediction, Comparative models, Homology, Threading/Fold recognition model, Energy landscape; Validation.

Structure prediction of small proteins using ab-initio stochastic simulation models:
Lattice simulation, Random walk model, Self-avoiding model, HP- models, Structure prediction of small proteins using ab initio Deterministic simulation models, Molecular Dynamics principle, Ergodic hypothesis, Use of Newtonian equations of motion, Structure optimization/refinement techniques, Steepest descent, GA simulated Annealing.

RNA structure prediction & Tools
Secondary Structure prediction, validation techniques for proteins: Calculations of Potential energy, Ramachandran Score & Ramachandran Z-score, Visualization, validation, Simulation, Gromacs, prediction using Modeller, Rose TTA Google AlphaFold.

Text Book:

- Introduction to Protein Structure: Carl Branden, John Tooze (Garland)
- Proteins: Structures and Molecular Properties: Thomas E. Creighton (Freeman)

Reference Books

- Guidelines for practical's: A two credit lab is to be conducted by covering them relevant and useful topics from aforementioned syllabus.
- Molecular Modelling: Principles and Applications (2ndEdition): Andrew R. Leach (Prentice Hall)

Next Generation Sequencing Tools and Algorithms (AS4103)

Objective: To get acquainted with the high throughput sequencing data and its processing and to enable the students to ponder more about the string processing

Course Outcome

Students will be able to:

- Work with real-world genomic and transcriptomic data
- Gain proficiency in sequence matching and assembly techniques and tools
- Gain competence in applying data science tools to biological data and skills

DNA sequencing, strings, and matching

DNA sequencers and working principle, DNA as a string. Parsing and manipulating real genome sequences and real DNA sequencing data. Naïve exact matching, homology detection; optimal pair-wises sequence alignment, alignment score statistics, efficient database searches (BLAST), Data science of metabolomics, pathway models.

Preprocessing, indexing, and approximate matching

Improving on naïve exact matching with Boyer-Moore. Preprocessing and indexing. grouping and ordering, Approximate matching and the pigeonhole principle. Edit distance, assembly, overlaps, Algorithms for computing edit distance. Dynamic programming. Global and local alignment. De novo assembly. Overlaps and overlap graphs.

Algorithms for assembly

Shortest common superstring and the greedy version. De Bruijn graphs and Eulerian walks. How real assemblers work. The future of assembly.

Data variability and replication

Data transforms, Clustering, Dimension reduction, Pre-processing and normalization, Linear models with categorical covariates, Logistic regression, Null and alternative hypotheses analysis, false discovery rate, permutation and boot strapping, GEO.

Text Book

- Bioinformatics Algorithms: An Active Learning Approach, by Phillip Compeau & Pavel Pevzner, Active Learning Publishers.
- Bioinformatics with Python Cookbook: Use modern Python libraries and applications to solve real-world computational biology problems, by Tiago Antao, Packet Publishing.

Reference Books

- DNA Sequencing From Experimental Methods To Bioinformatics by Alphey, Luke
- Next-Generation Sequencing Data Analysis by Xinkun Wang. Biological Information System and Management

Circuits and Instrumentation for Biomedical Engineering (AS4500)

Objective: To instruct about medical instruments currently in use in the medical domain with a special focus on the building blocks of such instruments.

Course Outcome
Students will be able to:

- Become familiar with key Medical Devices such as ECG, EMG, EEG, Cardiac Output Computer, Blood Pressure Measurement, ultrasound Machine, etc.,
- Know their operation principle, static and dynamic characteristics.

Transducers for Biomedical Application
Resistive transducers – Muscle force and Stress (Strain gauge), Spirometers (Potentiometric), humidity, Respiration (Thermistor); Inductive Transducers – Flow measurements, muscle movement (LVDT).

Capacitive Transducers
Heart sound measurement, Pulse pick up; Photoelectric Transducers - Pulse transducers, Blood pressure, oxygen Analyses; Piezoelectric Transducers – Pulse pickup, ultrasonic blood flowmeter; Chemical Transducer.

Operation principle, static and dynamic characteristics
ECG (Amplifiers and Circuits), EEG, Plethysmography, Cardiac Output Measurement. Ultrasonic, Transducers, and Ultrasonic Imaging, Beam Steering, Flow meters, Full Body Plethysmograph, EMG, LabVIEW

Text Book

- D. Patranabis, Sensors and Transducers, Prentice Hall of India, 2nd Edition,1984
- H. S. Kalsi , Electronics instrumentation, Tata Mc Grow Hill education Pvt. Ltd., 3rdedition 2010.

Reference

- Jon. B. Olansen and Eric Rosow, Virtual Bio-Instrumentation Biomedical, Clinical and Healthcare Applications using LabVIEW, Prentice Hall, first edition, 2002.

Biomechanics (AS4501)

Objective: To teach the concepts of mechanics concerning human movement, particularly those about exercise, sport, and physical activity.

Course Outcome
Students will be able to:

- Understand mechanical and anatomical principles from a mechanical perspective.
- Understand the domain of Biofluid mechanics and Cardiovascular mechanics
- Gain an understanding of disease of cardiovascular system & Artificial heart valve.
- Learn the concepts of Mechanical properties of biological materials.

Introduction to biomechanics
Joint mechanics, Human joint forces, Mechanics of elbow joints, Mechanics of shoulder joints, Mechanics of hip joints, Mechanics of knee joints, Mechanics of ankle joints

Tissue mechanics
Mechanical properties, Biological materials, Bone as composite material, Adaptation of bone stress and strain, Properties of cortical bone, cancellous bone, Teeth and its properties, Viscoelasicity, Dynamic behavior, Viscoelastic model, Soft tissue mechanics & properties: collagen, Elastin and mucopolysaccarides, Mechanical testing of soft tissue

Human locomotion, Gait analysis
Events of gait, Variable measured during gait, Motion analysis, Energy considerations, Muscles function, Force data, Prediction of segment moment of inertia, Measurement devices, Kinematics, Foot pressure pedobarograph.

Biofluid mechanics
Viscosity and viscometry, Capillary viscometer, Coaxial cylindrical viscometer, Cone and plate viscometer, Blood, Model of peripheral circulation, Coagulation, Blood rheology and its clinical application, Red cell size and shape, Cell membrane, Osmotic swelling, Area dilation, Shear of membrane, Synovial fluid, Cardiovascular mechanics.

Text Book:

- Fung, Y. C.: Biomechanics: Mech. Properties of Living Tissues. 2nd Ed., Springer
- C. Ross Ethier and Craig A. Simmons: Introductory Biomechanics: From Cells to Organisms. Cambridge University Press.
- J.D. Humphrey and S.L. Delange. An Introduction to Biomechanics: Solids and Fluids, Analysis and Design. Springer.

Reference Books

- B. Alberts, D. Bray, J. Levis, M. Raff, K. Roberts & J. D. Watson: Molecular Biology of the Cell; 5th Ed, Garland Science.

Bio-signal Processing (AS 4530)

Objective: To comprehend biological signal acquisition, sampling rate, and analysis.

Course Outcome
Students will be able to:

- Get familiar with discrete domain analysis and application of signal processing tools to extract information relevant to the medical domain.
- Become conversant with implementations of various signal processing functions in MATLAB environment.

Continuous-time signals and systems
Essentials of continuous-time signals and systems: convolution; Discrete-time signals and systems.

Sampling and quantization
Sampling and quantization, the sampling theorem and signal reconstruction; Z-transform, Filters

Fourier transforms
System transfer functions, Frequency analysis of discrete signals and systems: the discrete Fourier transform,

Power spectrum estimation
Power spectrum estimation and system identification; Systems with Feedback Control: stability analysis.

Text Books

- A.V. Oppenheim, A.S. Willsky & H.S. Nawab: Signals & Systems, Prentice Hall, India, 1997

Reference Books

- Discrete Time Signal Processing, Oppenheim, Schaefer, Pearson

Mathematics and Statistics for Biology (AS4531)

Objective: To make understand basic concepts of Matrix Theory, ODE, key probability distribution, and statistical tools.

Course Outcome
Students will be able to:

- Solve systems of linear equations and ordinary differential equations and apply key probability distributions to biological data.
- Analyze biological data using statistical tests.
- Model biological data using ODE and infer the data using statistical tools.

Matrices
Addition, multiplication, transpose, inverse and determinant of a square matrix, Gauss Elimination Method to solve the system of linear equations, Cramer's Rule, Rank of a matrix, Eigen Value and Eigen Vectors, Algebraic multiplicity and geometric multiplicity of an eigenvalue, Diagonalizability.

Ordinary Differential Equations (ODE)
Separable first-order ODE, Exact first-order ODE, Homogeneous first-order ODE,

Basic concepts of Probability
Review of the basic concepts of Probability (up to Bayes Theorem) and Statistics (Central tendencies and standard deviations) Probability Distribution functions: Binomial, Poisson and Normal distributions, Central Limit Theorem and its applications.

Sampling distribution
Estimation, Interval estimation, Confidence interval, Test of hypotheses, Z-test, t-test, the chi-square test. Correlation and Regression analyses, Correlation Coefficients, linear regression (one variable).

Text Book

- Advanced Engineering Mathematics by Erwin Kreyszig.
- Biostatistics-A Foundation for Analysis in the Health Sciences' by Wayne E. Daniel and Chad L. Gross.

Reference Book

- Fundamental of Biostatistics' by Bernard Rosner

Molecular Biology (AS4550)

Objective: To make understand basic biomolecules involved in cell structure and functions in prokaryotes and eukaryotic cells and basic structure of DNA, RNA, & protein.

Course Outcome
Students will be able to:

- Learn the basic structure of DNA, RNA, and protein.
- Understand molecular pathways control cellular functions
- Develop critical thinking and laboratory skills like plasmid and genomic DNA purification, Agarose gel electrophoresis, isolations of proteins, and PAGE analysis.

Biomolecules
Biomolecules involved in cell structure and functions in prokaryotes and eukaryotic cells. Structure of nucleotides, the chemical structure of DNA and RNA, Watson-Crick model, Supercoiled DNA. Genome organization in prokaryotes and eukaryotes and epigenetics.

Central dogma
DNA replication, repair and recombination, PCR, Gel Electrophoresis, Transcription. Structure and function of RNA polymerases. Transcription factors and machinery in Prokaryotes, formation of initiation complex, transcription activators and repressors.

Protein synthesis
Protein synthesis and processing Ribosome, formation of initiation complex, initiation factors, and their regulation, elongation and elongation factors, termination, genetic code, SDS PAGE

Cell cycle
Study of cell cycle and apoptosis, ROS, techniques for detection of Apoptosis and ROS, FACS

Text Books

- Freifelder D (2012). Molecular Biology, 5th edition. Narosa Publishing House, India
- Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York. iii. Allison A. Lizabeth (2012) Fundamental Molecular Biology, 2nd Edition. J Willey and Sons, Hoboken,New Jersey.

Reference Books

- Freifelder D and Malacinski GM (2005) Essentials of Molecular Biology, 4th Edition, John and Bartlett Publishing, UK
- Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.

Anatomy & Physiology (AS4551)

Objective: To make learn the concepts of the different levels of structural organization that make up the human body and explain their relationships.

Course Outcome
Students will be able to:

- Get an overview of how the body is organized, and how the body's organ systems work together.
- Understand the different organ systems of the human body and explain the major functions of each.

Bones
Bones of an appendicular skeleton – Scapula, humerus, radius, ulna, Joint - Hip, Femur, ankle, and foot

Muscles
Principal Muscles – Deltoid, Biceps, triceps, respiratory, abdominal and gluteal

Systemic physiology
Nervous System, Neuromuscular system; Blood and lymph; Circulatory system; Respiratory and Cardiovascular system.

Gastro-intestinal system
Kidney and excretory system, Sensory systems- visual, auditory, vestibular

Text Books

- Arthur C. Guyton: Textbook of Medical Physiology, 8th ed, Prism Books (Pvt) Ltd & W.B. Saunders Company, 1991.
- W. F. Ganong, Review of Medical Physiology, 13th ed., Prentice-Hall, 17th edition, 1995.

Reference Books

Advanced Medical Instrumentation (AS4200)

Objective: To impart working knowledge of real-time and embedded systems in the healthcare domain

Course Outcome
Students will be able to:

- Gain familiarity with device safety-associated regulations.
- Became aware of micro and nano-scale sensors and devices for healthcare.

Microcontroller and microprocessors
Concept of microcontrollers, microprocessors, device safety, ethics, and regulatory standards in medical instruments, EMI testing.

Sensors and Micro/Nanodevices
Molecular/ MEMS Sensors and Micro/Nanodevices for Biomedical Engineering Applications,

Embedded Systems & Real- Time Systems
Biomedical Instrument Design, Introduction to Embedded Systems & Real- Time Systems for Bio-signals & DSP.

Text Books

- R. S. Khandpur “Handbook of Biomedical Instrumentation”, Tata McGraw Hill.
- Carr& Brown, “Introduction to Biomedical Equipment Technology” Pearson Education, Asia.
- J.Webster, “Bioinstrumentation”, Wiley & Sons.
- R S Khandpur, Handbook of Analytical Instruments, Second Edition

Reference Books

- Joseph Bronzing, “Biomedical Engineering and Instrumentation”, PWS Engg. , Boston.
- Geddes & Baker, “Principles of Applied Biomedical Instrumentation” Wiley.
- Leslie Cromwell, “Biomedical Instrumentation and Measurements”

Biomedical Imaging (AS4201)

Objective: To develop background on the building blocks of medical imaging instruments

Course Outcome
Students will be able to:

- Gain knowledge of the physics of medical imaging.
- Learn the sources of signals and correlation with tissue features.

US imaging
Ultrasound wave propagation in homogenous medium, scattering, absorption and attenuation of ultrasound waves in tissue, pulse-echo imaging, pulse parameters, ultrasound transducers, field calculation for a single element transducer, delay-sum beam forming for array transducers, Doppler ultrasound.

Optical coherence
Tomography-Michelson Morley experiment, X-ray imaging- Instrumentation, mechanism of attenuation of X-ray in tissue, scintillation detection, digital radiography, X-ray CT, back projection algorithm

MRI imaging-angular momentum
Nuclear magnetic moment, Zeeman effect, Larmour precision, T 1, T 2, T 2 * relaxations, chemical shift, free induction decay, 900, 1800 pulse sequence, magnetic coils, localization of MRI signals.

Nuclear imaging
introduction to SPECT, and PET, pair production, coincidence detection

Text Books

- The Essential Physics of Medical Imaging, Bushberg, Lippincott, Williams and Wilkins, Third Edition.
- The Physics of Medical Imaging, Webb, CRC Press, 1988.

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M.TECH- EC

Applicable with effect from 2023 admitted batch and onwards

Digital System Design (EC 4001)

Objectives: To make students familiar with the fundamentals of Digital circuit and system Design.

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

- design the digital integrated circuits and systems and
- estimate the performance.

Introduction
MOSFETs, CMOS process design kit, Static Characteristics: Introduction, Resistive-Load Inverters, Inverters with n-Type MOSFET Load, CMOS Inverter. Dynamic characteristics and interconnect effect: Introduction, Delay-Time Definitions, Calculation of Delay-Times, Inverter Design with Delay Constraints, Estimation of Interconnect Parasitic, Calculation of Interconnect Delay, Switching Power Dissipation of CMOS Inverters..

Combinational and Sequential Circuits

MOS Logic Circuits with Depletion nMOS Loads, CMOS Logic Circuits, Complex Logic Circuits, CMOS Transmission Gates (Pass Gates), Behavior of Bistable Elements, SR Latch Circuits, Clocked Latch and Flip-Flop Circuits, CMOS D-Latch and Edge-Triggered FlipFlop..

Dynamic Logic Circuits
Introduction, Basic Principles of Pass Transistor Circuits, Dynamic CMOS Circuit Techniques like Precharge-Evaluation logic, NORA, ZIPPER, Stick Diagrams, Physical Design Rules; Layout Designing; Euler's Rule for VLSI Physical Design

Clock Generation, Distribution, and Timing Analysis
Simple clock generation circuits, Clock Distribution schemes, Input and Output Interface circuits: Set up time, hold time, clock skew, slack, calculation of set up time and hold time violation, clock frequency, propagation delay, metastability, Standard designs of Dynamic Random Access Memory (DRAM), Static Random Access Memory (SRAM) and Non-volatile Memory, Flash Memory.

Text Books

- Kang, Sung-Mo, and Yusuf Leblebici. CMOS digital integrated circuits. Tata McGraw-Hill Education, 2003

Reference Books

- Uyemura, John P. "Introduction to VLSI circuits and systems." (2002).
- Rabaey, Jan M., Anantha P. Chandrakasan, and BorivojeNikolic. Digital integrated circuits. Vol. 2. Englewood Cliffs: Prentice hall, 2002.

VLSI Technology (EC 4002)

Objectives: : The subject provides an in-depth knowledge of how a semiconductor device is prepared right from the substrate preparation to device fabrication

Course Outcomes:

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

- to understand the technology and basic principles underlying the fabrication process of semiconductor devices.

Introduction
Crystal growth, and wafer preparation: crystal structures, wafer fabrication, crystal defects, gettering.

Thermal Oxidation
Oxidation kinetics, impurity redistribution during oxidation, oxide charges, nitridation of Silicon.

Lithography
Photolithography steps, photoresists, wet and dry etching, introduction to E-beam, X-ray and ion-Beam lithography

Basic diffusion process, equations, and profiles
Ion Implantation and implant range, Ion stopping and ion channeling interconnects, modern CVD and PVD techniques and systems, refractory metals, Modern CMOS processes.

Text Book

- J. D. Plummer, M. D. and P. D. Griffin, Silicon VLSI Technology: Fundamentals, Practice, and Modeling, Pearson Education.

Reference Books

- S. M. Sze, VLSI Technology, McGraw Hill Education, Second Edition.
- G. S. May and S M Sze, Fundamentals of Semiconductor Fabrication, John Wiley & Sons,
- S. K. Gandhi, VLSI Fabrication Principles: Silicon and Gallium Arsenide, John Wiley & Sons, Second Edition.

Solid State Devices (EC 4003)

Objectives: The objective of this course is to provide a comprehensive understanding of semiconductor physics, including quantum mechanical principles, semiconductor junctions, and the operation of key devices like Bipolar Junction Transistors and Field Effect Transistors

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

- Understand Quantum Mechanical Concepts and Charge Carrier Behavior
- Explore Semiconductor Junctions and Their Applications
- Analyze BJTs, FETs and their models

Basic Semiconductor Physics
Quantum mechanical concepts and atomic states, band structure, charge carriers, diffusion of carriers, BTE, etc.

Junctions
p-n junctions, Schottky barrier junctions, heterojunctions, ohmic contacts, introduction to photonic devices.

Bipolar Junction Transistors
principle of operation,I-V characteristics, Ebers-Moll Model, Gummel-Poon model, small signal amplifier

Field Effect Transistors
MOS Capacitor, MOSFET, principle of operation,I-V characteristics, short channel and non-ideal effects in MOSFETs

Text Books

- Michael Shur, Physics of Semiconductor Devices, PHI, 1995.
- Ben G. Streetman, Solid State Electronic Devices, PHI, 4th Edition.

Reference Books

- S. Sedra and K. C. Smith, Microelectronic Circuits, Oxford Univ. Press, 5th Edition..

Embedded System Design (EC 4004)

Objectives: To make students familiar with the fundamentals of embedded system Design and techniques

Course Outcomes:

At the end of this course, students will be able to

- to model and design the processor, memory, and controllers for the system applications

Evolution of processors for embedded application
High performance computing and low power computing; Moore's law and Amdahl's law; Brief overview of performance estimation; Performance gap in microprocessor and memory; Introduction of Cache hierarchy in processors; Memory elements and hierarchy (SRAM, DRAM, Flash, Hard Disk).Techniques for hardware Performance improvement; Design Process of embedded system; Hardware/Software Interface

ARM
Performance and efficiency of ARM architecture (ARM 7, ARM 9, ARM 11). Thumb and ARM Instruction set and Programming; Data processing, Data transfer, and Control flow instructions. Data Level Parallelism and Thread level parallelism, Memory Interfacing,, I/O interfacing, Interface IP: AMBA, DDR, Ethernet, USB, Analog IP: Data Converter and PLL, Embedded Memory IP; Serial Communication and Parallel Communication

Sensors and actuators
Interfacing to sensors and actuators, Constraints in design, Reaction constraints and execution constraints, Heterogeneity, Constructivity; Execution and Interaction Semantics, Composition of state machines, Hierarchical state machines.

Real Time Operating systems
Scheduling, Memory and I/O management, Bus I/O and networking considerations, System verification, Testing of embedded systems.

Text Books

Reference Books

- Heath, Steve. Embedded systems design. Newnes, 2002.
- Hennessy, John L., and David A. Patterson. Computer architecture: a quantitative approach. Elsevier, 2012.
- Wolf, Wayne. FPGA-based system design. Pearson Education, 2004.

Testing and Verification (EC 4005)

Objectives: To let the students exposed to Testing and to demonstrate their application on real time system.

Course Outcomes:

At the end of this course, students will be able to

- handle Verification Students will be exposed to Testing and explore many areas of Testing & Verification

Introduction
Basics of testing and fault modelling: Introduction- Principle of testing - types of testing - DC and AC parametric tests - fault modelling

Testing and testability
Testing and testability of combinational & sequential circuits, algorithms, Boundary scan, Memory, IDDQ.

Testing
Testable memory design - test algorithms for RAMs, IDDQ testing - testing methods - limitations

Built-in self-test
Test pattern generation (BIST) - Output response analysis – BIST architectures..

Text Books

- M.L. Bushnell and V.D. Agrawal, "Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits", Kluwar Academic Publishers.

Reference Books

- P. K. Lala, "Digital Circuit Testing and Testability", Academic Press.
- N.K. Jha and S.G. Gupta, "Testing of Digital Systems", Cambridge University Press.
- N. Zainalabedin, "Digital System Test and Testable Design: Using HDL Models and Architectures", Springer.

Analog Integrated Circuit Design (EC 4006)

Objectives: Students will be able to learn about the process flow of IC designing, importance and design of analog sub circuits, various amplifiers and will eventually learn the art of designing analog VLSI circuits.

Course Outcomes:

At the end of this course, students will demonstrate the ability to:

- Explain process flow of IC designing
- Develop analog sub circuits, Current mirrors etc
- Design various amplifiers like Differential amplifier, Cascode, Telescopic Amplifier etc
- Design analog and understanding of mixed signal circuits

Introduction to Analog IC Design
IC design flow, Device characteristics, Operation of Transistors, Equation and Models.

Analog Sub-Circuits and Single Stage Amplifiers
MOS Diode, Current Mirrors and their types, Single Stage Amplifiers CS, CG and CD and their frequency response, Design of Cascode Amplifier.

Multi Stage Amplifiers
Differential amplifier, op-amps, Compensations, Design of 2 stage op-amp and application

Others Amplifiers and Feedback
Design of Telescopic Amplifiers, Folded Cascode Amplifers, Feedback Techniques and Filters.

Text Books

- Gray, Paul R., and Robert G. Meyer. Analysis and Design of Analog Integrated Circuits. John Wiley & Sons, Inc., 1990
- Allen Holberg, CMOS Analog Circuit Design, 3rd Edition, OUP USA, 2012.

Reference Books

- Razavi, Behzad. Design of Analog CMOS Integrated circuits, McGraw Hill, 2nd Edition, 2017.

Advanced Digital Communication (EC 4075)

Objectives: To make students familiar with the Digital communication concepts and technologies.

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

- Apply mathematical modelling to problems in wireless digital communications.
- Identify modulation and demodulation techniques, coding and decoding scheme for the design of a transmitter and receiver.
- Evaluate the impact of noise on communication performance and design optimum receiver to mitigate these effects.
- Explore emerging technologies and standards in digital communication, such as 5G and beyond, and assess their applications in real-world scenarios.

Introduction
Review of digital communication, Passband pulse and quadrature-amplitude modulation, Pulse code modulation (PCM), Delta modulation, Inter-symbol interference and pulse shaping, Optimum detection, Probability of error analysis.

Introduction to Digital Modulation Techniques
Line Coding, Review of Digital modulation techniques, Multiplexing and multiple access techniques, Adaptive Modulation and Coding, Spread spectrum modulation, Probability of error analysis of digital modulation techniques

Source Coding
Mathematical models for information sources, Entropy and mutual information, Lossless data compression, Coding for discrete sources, Huffman coding, Run-length coding, Lempel-Ziv algorithm, Lossy data compression, Rate distortion functions

Advanced Channel Coding
Review of Linear Block codes and convolutional codes, LDPC codes, Turbo codes, serially concatenated codes, bit- interleaved coded modulation, Polar codes.

Text Books

- J. G. Proakis, Digital Communications, fourth edition, McGraw–Hill, 2001.
- B. Carlson et.al., Communication Systems: An Introduction to Signals and Noise in Electrical Communication, 4th Edition, McGraw Hill International, 2002.

Reference Books

- R. G. Gallager, Principles of Digital Communication, Cambridge University Press, 2008.
- S. Haykin, Communication Systems, John Wiley & Sons, 2001.

Statistical Signal Analysis (EC 4076)

Objectives: The subject provides an in-depth knowledge of Statistical Signal Analysis

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

- Exploit the knowledge of various mathematical models in wide range of engineering applications.
- Understand fundamental concepts of probability theory, including random variables, probability distributions, and expected values.
- Familiarize with the detection and estimation of random signals.
- Implement estimation and detection techniques, including parameter estimation and hypothesis testing, for real-world signal processing applications

Introduction
Review of random signals, Transformation (function) of random variables, Moment generating function, characteristic function, Conditional expectation, Sequences of random variables, Law of large numbers, Central limit theorem, Jointly Gaussian random vectors, Covariance matrices, Principal component analysis.

Introduction to Random Processes and Random Vectors
Wide-sense stationary processes, Ergodicity, Moments, Autocorrelation and autocovariance functions, Spectral representation of random signals, Poisson process, Gaussian processes, Wiener process, White noise, MA, AR, ARMA models, Overview of Markov Chains

Hypothesis Testing and Detection
Bayes Rule, Likelihood ratios, Sufficient statistics, Minimax Rule, Composite Hypothesis Testing, Neyman-Pearson test, Receiver operating characteristics

Parameter Estimation
Maximum likelihood estimation, Maximum a posteriori probability estimation, Minimum mean-square estimation, Linear least square estimation, Cramer Rao lower bound, Kalman filtering.

Text Book

- Papoulis, Probability, Random Variables and Stochastic Processes, 2nd Ed., McGraw Hill, 1983.
- H. L. Van Trees, Detection, Estimation and Modulation Theory (Part I), John Wiley & Sons, 2001.

Reference Books

- Larson and B.O. Schubert, Stochastic Processes, Vol. I and II, Holden-Day, 1979.
- S. M. Kay, Fundamentals of Statistical Signal Processing - Estimation Theory (Vol. 1), Prentice- Hall, Inc., 1993, ISBN: 978-0133457117.

Radiating System (EC 4077)

Objectives: The objective is to provide a comprehensive understanding of electromagnetic theory, focusing on wave propagation, radiation, antenna, and the working principles of different antenna types, with an emphasis on design and analysis.

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

- Learn the basics of radiation principle and foundational concepts through mathematical analysis and will gain insight about fundamental parameters and terminology used in Antenna Engineering.
- Analyze and design various types of antennas to achieve a specified performance.
- understand various modes of EM wave propagation.
- acquire hands-on experience with antenna measurements and testing

Introduction to Electromagnetic Theory
Review of Maxwell's Equation and boundary conditions, Wave propagation, Normal and Oblique incidence of plane wave at conducting and dielectric media

Radiation Integrals and Auxiliary Potential Functions
Vector Potential, Electric and Magnetic Fields for Electric and Magnetic Current Sources, Solution of the Inhomogeneous Vector Potential Wave Equation, Far-Field Radiation, Duality Theorem, Reciprocity and Reaction Theorems

Antenna Fundamentals & Radiation from Wires and Loops
Principle of Radiation, Radiation Pattern, Field Regions, Radiation Power Density, Beamwidth, Directivity, Antenna Efficiency, Gain, Bandwidth, Polarization, Input Impedance, Maximum Directivity and Maximum Effective Area, Friis Transmission Equation and Radar Range Equation. Infinitesimal dipole, finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.

Working Principle of Antenns, Antenna Arrays & Microstrip Antennas
Two-Element Array, N-Element Linear Array, Design Procedure, Synthesis of antenna arrays, Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension, folded dipole, Yagi-Uda, Log-periodic, Parabolic reflector, Horn, V-antenna, Rhombic antenna, Resonant and non-resonant antenna. Microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas.

Text Books

- C A Balanis, Antenna Theory and Design.3rd Ed., John Wiley & Sons. 2005.
- R. Harish, and M. Sachidananda. Antennas and wave propagation. Oxford University Press, USA, 2007.

Reference Books

- R. S. Elliot, Antenna Theory and Design. Revised edition, Wiley-IEEE Press. 2003.
- R. E. Collin, Antennas and Radio Wave Propagation. McGraw-Hill. 1985.
- R. K. Shevgaonkar, Electromagnetic waves. Tata McGraw-Hill Education, 2005.

Introduction to Machine learning (EC 4078)

Objectives: To make students familiar with techniques for analysis and modelling of speech both from signal processing and machine learning aspects coving number of applications

Course Outcomes:

At the end of this course, students will be able to learn the

- principles and algorithms for machine learning

Introduction to Machine Learning
Basic ML concepts and examples, Basic Probability Notations, Bayesian Inference, Basic concepts of statistics, probability and calculus.

Supervised Machine Learning
Regression (Linear Regression, Ridge regression, Regression Trees, Non-linear regression, Bayesian Linear regression, polynomial regression, Lasso regression, Gradient decent) Classification (Random forest, Decision Trees etc Maximum Likelihood estimation, Regularization/MAP, Soft/Hard Margin SVM, SVM Duality

Unsupervised Machine Learning
(K-means clustering (Soft/Hard), KNN (k-nearest neighbors), Hierarchical clustering, Anomaly detection, Neural networks, Principal Component Analysis, Independent Component Analysis, A-priori algorithm, Posteriori Algorithm, Singular value decomposition) Association

Reinforcement Machine Learning
Reinforcement Learning overview, The learning Task, Q-Learning, Nondeterministic Q-Learning, Temporal Difference-Learning, RL-General formulation, Multi-armed Bandits, Markov Decision Process and Deep Reinforcement Learning

Text Books

Reference Books

- Pattern Recognition and Machine Learning by Bishop, Springer, 2006.
- Machine Learning: A Probabilistic Perspective by Kevin P. Murphy, MIT Press, 2012
- The Elements of Statistical Learning, 2nd edition by Hastie, Tibshirani and Friedman, Springer-Verlag, 2008.
- Bayesian Reasoning and Machine Learning by David Barber, Cambridge University Press, 2012.
- Information Theory, Inference, and Learning Algorithms by David Mackay, Cambridge University Press, 2003.

Principles of Wireless Communications (EC 4035)

Objectives: To enable the student to synthesis and analyse wireless and mobile cellular communication systems over stochastic fading channels.

Course Outcomes:

At the end of this course, students will be able to

- analyse and design wireless and mobile cellular systems, and 2) the students will have the ability to work in advance areas of wireless and mobile cellular environments

Introduction
Evolution of mobile radio communication, Cellular communication, Cellular system design fundamentals: frequency reuse concept, channel assignment, co-channel interference, adjacent channel interference, system capacity, cell splitting, sectoring, etc., Cellular System Architectures: GSM system, Multiple access techniques of cellular networks, Orthogonal frequency division multiplexing LTE architecture, 5G architecture

Physical modelling for wireless channels
Link budget design using path-loss model, Outdoor and indoor propagation models, small scale multipath propagation, Delay spread, Coherence bandwidth, Doppler spread & Coherence time, Flat fading, Frequency selective fading, Fast fading, Slow fading

Diversity in Wireless Communication
Diversity concept, Non-coherent and coherent reception, Time diversity, Repetition coding, Receiver diversity (SC, EGC and MRC), Multiple receive antenna system model and its error performance analysis, Transmit diversity, Channel estimation for multi-antenna system, Diversity order analysis

5G and Beyond Wireless Technologies
Cooperative relaying communications, Cognitive radio networks, Device-to-Device (D2D) Communications, Ambient backscatter communications (AmBC), Reconfigurable intelligent surface (RIS), Non-orthogonal multiple access (NOMA)

Text Books

- J. Goldsmith, Wireless Communications, Cambridge University Press, 2005.
- T. S. Rappaport, Wireless Communications, Prentice Hall, 1996.

Reference Books

- D. Tse and P. Viswanath, Fundamentals of Wireless Communications, Cambridge University Press, 2005.
- M. K. Simon and M. S. Alouini, Digital Communications over Fading Channels, John Wiley & Sons, 2000.

Recent Advances in Machine Learning (EC 4036)

Objectives: To provide basics of recent techniques of machine learning and to introduce students with deep reinforcement learning methods

Course Outcome

At the end of this course, students will be able to

- acquire the advanced methods of machine learning
- understand the Deep Learning algorithms and its properties
- examine the applications of Deep ML and Deep RL in the communication.
- develop student's modeling and analytical skill for solving complex sequential decision problems

Introduction

Artificial Neural Networks, Deep Neural Networks

Generative adversarial networks (GAN)

Q learning, Deep Reinforcement Learning, Deep Q Network, Policy network

Monte Carlo Tree Search, Applications to communication systems, IoT, and cyber physical systems

Text Book

- Vivek S. Borkar, Stochastic Approximation: A Dynamical Systems Viewpoint, Springer, 2nd Edition, 2022.
- 2. Harold Kushner and G. George Yin, Stochastic Approximation and Recursive Algorithms and Applications, Springer, 2nd Edition, 2003.
- 3. Richard S. Sutton and Andrew G. Barto, Reinforcement Learning: An Introduction, Bradford Books, 2nd Edition, 2018.
- 4. David Silver et. al., Mastering the game of Go with Deep neural networks and tree search, Nature, Volume 529, Feb., 2016.
- 5. Ian Goodfellow, Yoshua Bengio and Aaron Courville, Deep Learning, An MIT Press Book, 2016.

MBA

Applicable with effect from 2023 admitted batch and onwards

Financial Statements and Analysis (MS4101)

Objective: This course will help the students to understand the basics of Financial Statements analysis from the perspective of its application in various business decisions.

Course Outcomes

After completing the course, the students will be able to:

- Understand the structure and components of financial statements & Analysis.
- Apply financial analysis techniques to make informed business decisions.
- Understand the limitations and challenges of financial statement analysis.

Introduction to Financial Statements

Financial Statements & Accounting Principles, Overview of financial statements, Users of financial statements, role of accounting in financial reporting, Types of financial statements, Accounting equation & related concepts, Annual Reports & their importance.

The Balance Sheet and Income Statement

Structure of the balance sheet: Assets, cash, inventory, property, and equipment, Liabilities, accounts payable, loans, and long-term debt. Equity, Analyzing liquidity and solvency using the balance sheet, Common size balance sheet analysis. Structure of the Income Statement, Revenues**,** Expenses, Cost of goods sold, operating expenses, and non-operating expenses., Net Income, EPS, Common Size Income Statement Analysis.

Depreciation and Inventory Valuation

Concept, methods of Depreciation, effects on balance sheet & income statement, Methods of Inventory Valuation, Impact of Inventory Valuation, gross profit, and tax implications, need for adjusting inventory values in financial statements.

The Cash Flow Statement

Components, Operating Activities, Investing Activities, Financing Activities, Importance of Cash Flow in Assessing Financial Health, Distinguishing between cash flow and net income, cash flow cycle and its implications for liquidity, understanding free cash flows.

Financial Statement Analysis Techniques

Vertical & Horizontal Analysis, Ratio Analysis, DuPont Analysis, Interpreting Financial Statements for Decision-Making, Evaluating Company Performance, Benchmarking Against Industry Standards and Competitors, Variation Across Different Industries.

Reference Books:

- “Financial Statement Analysis”, Charles H. Gibson, South-Western, 9781133189404.
- “Financial Statements: A Step-by-Step Guide to Understanding and Creating Financial Reports”, Thomas R. Ittelson, Career Press Incorporated, 9781601638618.
- “Financial Statement Analysis”,K. R. Subramanyam, John Wild, McGraw-Hill Education, 9780073379432.

Business Statistics (MS4102)

Objective: To acquaint students with various statistical methods and their applications in different fields.

Course Outcomes
The students shall be able to:

- Explain basic statistical concepts
- Independently calculate basic statistical parameters
- Choose a statistical method for solving practical problems

Sampling, sampling distribution and Measurement & Scaling Techniques
Meaning, Steps, types, Data collection, Sources – advantages/disadvantages. Data collection Methods: Observations, Survey, Interview and Questionnaire design, Qualitative Techniques of data collection, Scales, Criteria for good measurement, attitude measurement, Thurston-equal appearing interval scale. Descriptive statistics, Averages, Partition Values, Comparison of the various Measures of Central Tendencies.

Dispersion, Correlation and Regression Analysis
Measures of Dispersion, Variance Skewness, Karl- Pearson Co-efficient of skewness. Correlation and regression, Karl Pearson's coefficient of Correlation, Rank Correlation, Concurrent Deviation, Regression

Probability & Sampling Distribution and Estimation
Concept and Definition, Sample Space and Events, Probability, Random Variables and Concept of Probability Distribution. Theoretical Probability Distributions: Binomial, Poisson and Normal and problems on it. Baye's Theorem, Ssampling distribution of mean and proportion, CLT, sampling techniques. Estimation, determining the sample size.

Hypothesis Formulation, Testing of hypothesis and inferences
Procedure of testing hypothesis, Type I and Type II Errors. Parametric tests: Z- Test, t-test, F-test, Analysis of Variance – One-Way and Two-way classification.
Non parametric tests Chi-Square test (Problems)

Text Books:

- Levin, Richard, David S. Rubin. Statistics for Management. Pearson Education.
- Anderson Sweeney and William. Statistics for Business and Economics. Cengage Learning.
- Ken Black. Applied Business Statistics. Wiley Publication.

Reference Books:

- Berenson and Levine. Basic Business Statistics: Concepts and Applications. Pearson Education.
- Siegel Andrew F. Practical Business Statistics. McGraw Hill.
- Vohra N. D., Business Statistics, McGraw Hill.

Research Methodology (MS4103)

Objective: The primary objective of this course is to acquaint students with fundamentals of research methods. The course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis.

Course Outcome

Students will be able to

- Gain a comprehensive understanding of Research Foundation and Understand various research designs and techniques.
- Identify various sources of information for literature review and data collection and will gather and analyze data using appropriate statistical tools.
- Demonstrate the ability to interpret and present research findings effectively.
- Write structured, coherent, and well-argued research reports or theses, and present research findings effectively using both written and oral communication.

Introduction to Research: Foundations of Research, Type of Research,Qualities of Researcher, Components of the Research Problem, Research Process, Research Design

Theory Building & Framework Development: Research Question, Theory Development Process, Hypothesis Development, Scale Development, Testing the Scale

Sampling & Questionnaire Development: Sampling Process and Methods, Data quality issues, Questionnaire Development techniques, Data Collection - Primary Data & Secondary Data, Method of Data Collection, Fieldwork and Data Preparation

Data Analysis and Report Writing: Quantitative and Qualitative Data Analysis, Parametric Hypothesis Testing, Non-Parametric Hypotheses Testing, Writing and presenting project report, Oral presentation of the report

Text Books

- "Research Methodology Methods & Techniques", C. R. Kothari, Fifth Edition, 2023, New Age International Private Limited,ISBN 978-9389802559.
- "Marketing Research", G.C. Beri, Fifth Edition, 2023, McGraw Hill Education, ISBN 978-1259004902.
- "Business Research Methods", W.G. Zikmund, B.J. Babin, J.C. Carr, M. Griffin,Ninth Edition, 2013, Cengage India Private Limited, ISBN 978-9353503260.
- "Business Research Methods", N. Bajpai, Second Edition, 2017, Pearson Education, ISBN 978-9332585515

Reference Books

- "Business Research Methods", D. Cooper, P. Schindler, Eleventh Edition, 2017, McGraw Hill Education, ISBN 978-1259001857.

Economics (MS4104)

Objective: The course focuses on maximizing profitability by applying economic analysis to a wide array of business problems given the fundamental assumption of economic analysis that states people behave rationally, optimally and self-interestedly.

Course Outcome

Students will be able to

- Demonstrate comprehensive knowledge and understanding on the basic concepts, various behaviors and nature of economics
- Explain the Elasticity of demand and supply and its influence on determination of price in the market and to understand how factors of production can be used optimally to produce goods and services
- Gain analytical skills for understanding market structure and to demonstrate the equilibrium price output determination under different market conditions.

Fundamental economic concepts & Economic Way of Thinking

Consumer analysis – Total &marginal Utility; Law of diminishing marginal utility; consumer equilibrium; law of Equi-marginal utility and demand forecasting

Demand and Supply and their application

Law of Demand; movement along the demand curve& shift of the demand curve; Elasticity of demand-Price, income & cross elasticity of demand; Law of Supply; Movement along the supply curve and shift of supply curve

Production and cost decisions

Production function, Variation of output in Short & long run; Law of Variable Proportions; Concept of cost of Production; Behaviour of Cost in short & long-run; Revenue Concept

Market Structure and Strategy Decision

Perfect Competition; Monopoly Competition; Monopolistic Competition; Rules of Profit-Maximization, Business Cycles, Control Measures & Business decisions

Text Book:

- Economics 19th Edition by Paul A Samuelson,William D Nordhaus
- Managerial Economics: A Problem- Solving Approach , 2nd Edition, Froeb/McCann, (South-Western,2010).
- Microeconomics (GlobalEdition) ,8thed.,Robert S.Pindyck &Daniel L.Rubin feld, Pearson/Prentice Hall.

References:

- Charles Wheelan , Naked Economics-Undressing the Dismal Science, Norton
- Steven E. Landsburg , Armchair Economist, Free Press
- Tim Harford ,The Undercover Economist, Abacus
- Robert Frank , The Economic Naturalist, Basic Books
- Avinash Dixit and Barry Nalebuff , Thinking Strategically, Norton

Management Thought and Environment (MS4105)

Objective: The objectives is to define management, describe the nature and scope of management, difference between management and administration, various levels of management; and to describe the various skills that are necessary for successful managers.

Course Outcome
Students will be able to

- understand how managers manage business organization
- familiarize with the nature of business environment and its components.
- develop conceptual framework of business environment and generate interest in international business.

Evolution of Management Thought
Management Practices. Management as a discipline Concept of Management and Principles of Management

Business Environment Analysis
Introduction to Business Environment Analysis of Business Environment, Internal and External Environment

Environment
Competitive Environment, Michael Porter's Five Forces Analysis, Role of government in Business, Legal framework in India, Economic environment

Social Responsibility
Corporate Social Responsibility Technological environment, Globalization, FDI

Text Book/References:

- Management by Peter Drucker
- Management Policy by Melvin J. Stanford
- The Philosophical Foundations of Management Thought By Jean-Etienne Joullié, Robert Spillane
- A History of Management Thought By Morgen Witzel

IT Infrastructure & Service Management (MS 4106)

Objective: To identify how a service can provide value, features of services, Service Management, challenges and recognize the goals and objectives of each Lifecycle.

Course Outcomes
Students will be able to:

- to understand the IT infrastructure and its components.
- gain insights into the current needs of IT-related services in organizations.
- Identify how a service can provide value and will recognize the importance of Service Management and the challenges service providers face.

IT infrastructure management
Evolution of IT infrastructure, Identification of Key IT infrastructure components, IT Infrastructure Audit and regulatory compliance, Developing resilient, responsive, and smart IT infrastructure for organizations, Tracking the Growth and change trajectory in enterprise-level software and service delivery systems, Identification of factors influencing dynamic organizational IT needs, Establishing a Generic IT ecosystem.

Information Technology Infrastructure Library (ITIL)
Revisiting the ITIL v3**,** Introductory Overview of ITIL v4**,** Introduction to ITIL best practice**,** Four dimensions of service management and their key role in effective services**,** ITIL service value chain**,** Key benefits of ITIL

Service Management
Concept of Service Management**,** SIPOC Model/SERVQUAL model**,** Service level Benchmarking**,** Introduction to Process Management**,** Decision Support System**,** Types of Services: i)Legacy system (On-premises)ii) Infrastructure/Architecture as a service.iii) Platform as a service. iv)Software as a service.

Continual Service Improvements
Introduction to Continual Service Improvements, Service Level Interoperability**,** Key Principles and Models of Continual Service Improvements.

References:

- ITIL is a framework of best practices developed in the UK by the Office of Government Commerce (OGC). The official ITIL website is at www.itil-officialsite.com, but much of the official information is at www.best-management-practice.com, run for OGC by The Stationery Office (TSO).
- The official overview, for free! Download the free 50-page book, An Introductory Overviewof ITIL V3, at www.best-management-practice.com/gempdf/itSMF_An_Introductory_Overview_of_ITIL_V3.pdf.
- Official ITIL Glossary of Terms and Definitions at www.itil-officialsite.com/InternationalActivities/TranslatedGlossaries.aspx.

Organizational Behavior (MS4107)

Objective: To let the students be exposed to the nature and concepts of organizations behavior and culture

Course Outcome

Students will be able to

- implement the process and will be trained for organizational challenges in future.

Introduction

Concept, Nature, Characteristics, conceptual Foundations and Importance, Models of Organizational Behavior, Management Challenge, A Paradigm Shift. Relationship with other Fields. Organizational Behavior: Cognitive Framework, Behavioristic Framework and Social Cognitive**,** Framework. Perception and Attribution: Concept, Nature, Process, Importance. Management and Behavioral Applications of Perception. Attitude: Concept, Process and Importance. Attitude Measurement. Attitudes and Work force Diversity. Personality: Concept.ature, Types and Theories of Personality Shaping. Personality Attitude and Job Satisfaction. Leaning: Concept and Theories of Leaning.

Motivation

Concepts and Their Application, Principles, Theories, Employee Recognition, Involvement, Motivating a Diverse Workforce. Leadership: Concept, Function. Style and Theories of Leadership-Trait, Behavioural and Situational Theories. Analysis of Interpersonal Relationship, Group Dynamics: Definition, Stages of Group Development, Group Cohesiveness, Formal and Informal Groups, Group Processes and Decision Making, Dysfunctional Groups

Organizational Power and Politics: Concept, Sources of Power, Distinction between Power, Authority and Influence, Approaches to Power, Political Implications of Power: Dysfunctional Uses of Power. Knowledge Management & Emotional Intelligence in Contemporary Business Organization. Organizational Change: Concept, Nature, etc, Kurt Lewin Theory of Change Conflict, Classification of Conflict Intra, Individual. Interpersonal, Inter group and Organizational. Resolution of conflict. Meaning and Types of Grievance and Process of Grievance Handling. Stress: Understanding Stress and Its Consequences, Causes of Stress, Managing Stress

Organizational Culture: Concept, Characteristics. Elements of Culture. Implications of Organization culture, Process of Organizational Culture.

References:

- Newstrom John W.-Organizational Behaviour: Human Behavioural Work (TataMcGrawHill,12"'Edition)
- Luthans Fred-Organizational Behaviour (Tata McGraw Hill)
- McShaneL.Steven. Glinow Mary AnnVon & Sharma Radha R.-Organizational Behaviour (Tata Mc GrawHill,3rdEdition)

Corporate Finance (MS4108)

Objective: This course aims to provide the students with the fundamental concepts, principles and approaches of corporate finance, and enable the students to apply relevant principles and approaches in solving problems of corporate finance.

Course Outcome
Students will be able to

- value stocks and bonds, assess the risk and return of assets, estimate a company's cost of capital, evaluate investment projects and
- determine whether a company is creating or destroying value and compensate shareholders in the most convenient way.

Introduction
Introduction to financial management Indian capital market, Time value of money. Conceptual Framework of Risk and Return

Capital Budgeting Risk Analysis
Estimation of cash flow Sources of Financing, Cost of capital

Capital structure & Leverages
Working capital management

Dividend
Dividend policy Banking institutions, non-banking financial companies, mutual funds, insurance organizations, development finance institutions

Text Book/References:

- Financial Management - Khan M. Y.& Jain P. K, 6Ie, TMH, 2011.
- Financial Management - Pandey I. M, 1 Ole, Vikas.
- Financial Management - Prasanna Chandra, 8Ie, TMH, 2011.
- Financial Management, Kapil, Pearson Education, 2011.
- Financial Management, Srivastav, Oxford University press, 2011.
- Fundamentals of Financial Management - Brigham & Houston, 1 Ole, Cengage Learning.
- Fundamentals of Financial Management – Vanhorns & Bhandari, Pearson Education.
- Contemporary Financial Management- Kothari & Dutta, Macmillan India Ltd.
- Fundamentals of Corporate Finance - Stephen A. Ross, Wester Field, Jordan, 8Ie, McGraw 2010.
- Fundamentals of Financial Management -Vanhorne & Wachowicz, I 3Ie, PHI, 2011.

Production & Operations Management (MS4109)

Objective: To understand the role of operations management in the overall business strategy of the firm.

Course Outcomes

Students will be able to:

- understand the roles and responsibilities of operations managers.
- recognize its interfaces with other functional areas within & outside the organization
- Understand the role of operations management in the overall business strategy of the firm.

Productivity & Forecasting

productivity ratio, measurement, index, awareness improvement maintenance (A.I.M) process. Production System Models of production system, Product vs. Services, Process-focused & product focused systems, Operations strategy, moving average, exponential smoothing, Regression analysis, coefficient of co-relation, Delphi, Market survey. Modern Trends in Manufacturing: Basic concepts of CAD, CAM, FMS, CIM, ISO 9000, Quality circle, Kaizen, Kanbans, Poke Yoke' supply chain management

Facilities Planning

Site location, facilities layout and various types, Objectives of Layout, Classification of Facilities, Basis for Types of Layouts, Nature of layout problems, Redesigning of a layout, Manufacturing facility layouts, Types of Layouts, Layout Planning, Evaluating Plant Layouts, Assembly Line Balancing, Material handling.

Production Planning & Control

Aggregate planning. Sequencing, Line balancing, Flow control, Dispatching, expediting, Gantt chart, line of balance, learning curve.

Project Management

Network scheduling, PERT. Critical path, Most likely time estimate, Resource leveling. Inventory Management: Basic Economic Order Quantity (EOQ) Model; Quantity Discount Models; Spare Parts Inventory; Manufacturing Resource Planning; Purchasing

Text Book:

- Operations Management by Jay Heizer, Barry Render, Chuck Munson, Amit Sachan (Twelfth Edition), Pearson Publishing
- Production and Operations Management – Manufacturing and Services, Chase, Richard B., Nicholas J. Aquilano and Robert F. Jacobs; Tata McGraw-Hill, New Delhi, 1999.

References:

- Succeeding in Project-Driven Organizations by Knutson Joan; Publisher: John Wiley.
- Production Systems: Planning, Analysis &Control : By —Riggs, J.L.(4th Edn.) John Wiley & Sons.

Operation Research (MS4110)

Objective: To gain some ability to recognize situations in a production system environment that suggests the use of certain quantitative methods to assist in decision making on operations management and strategy.

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Course Outcome

Students will be able to

- Gain an understanding and appreciation of the principles and applications relevant to the planning, design, and operations of manufacturing/service firms and to cultivate analytical thinking among students**.**

Introduction

Introduction to Operation Research Linear programming: sensitivity analysis; duality Transportation problem Assignment model

Decision making

Decision-making environments Decision tree approach and its applications.

Replacement

Replacement Problem Game Theory: Concept of game; Dominance Meth

Queuing Theory

Queuing Theory Project Management

References:

- Taha Hamdy – Operations Research – An Introduction (Prentice-Hall, 7th edition)
- Hiller and Lieberman. Introduction to Operations Research. McGraw Hill.
- Sharma J K – Operations Research (Pearson, 3rd Edition)
- Srinivasan, Operations Research, PHI.
- Paneerselvam, Operations Research, PHI

Human Resource Management (MS4111)

Objective: To let student be exposed to the Human resource management process and techniques.

Course Outcome
Students will be able to

- implement the process and will be trained for organizational challenges in future**.**

Human Resources Management (HRM)
Meaning, Nature and Scope, HRM functions, objectives, Evolution. HRM in India: evolution and principles of HRD, HRD Vs. Personnel functions, Role of HR managers. Strategic HRM, Nature of Strategies and Strategic Management, Strategic Management Process-Environmental Scanning, Strategy Formulation, Implementation, and evaluation.

Human Resources planning
Definition, purposes, processes and limiting factors. HRIS, HR accounting and audit, Job Analysis- Job Description, Job Specification. The systematic approach to recruitment: recruitment policy, recruitment procedures, recruitment methods and evaluation. The systematic approach to selection: the selection procedure, the design of application form, selection methods, the offer of employment, and evaluation of process.

Training and Development
Purpose, Methods and issues of training and management development programmers Performance Appraisal: Definition, Purpose of appraisal, Procedures and Techniques including 360-degree Performance Appraisal, Job Evaluation. Compensation Administration: Nature and Objectives of compensation, components of pay structure in India, Wage Policy in India Minimum Wage, Fair Wage and Living Wage. Incentive Payments, Prerequisites for an effective incentive system, Types and Scope of incentive scheme, Incentive. Schemes in Indian Industries, Fringe Benefits.

Discipline and Grievance Procedures
Definition, Disciplinary Procedure, Grievance Handling Procedure. Nature, importance, and approaches of Industrial Relations. Promotion, Transfer and Separation: Promotion-purpose, principles, and types; Transfer reason, principles, and types; Separation-layoff, resignation, dismissal, retrenchment, Voluntary Retirement Scheme.

Text Book:

- “Human Resource Management, Text and Cases”, TMH.
- Dr. Anjali Ghanekar, “Essentials of Human Resource Management”, Everest.
- Wayne. F.Cascio, Ranjeet Nambudiri, “Managing Human Resource Management”, 8th Edition, TMH

References:

- Aswathappa K, Human Resource and Personnel Management, (TataMcGrawHill,5lhEd.)
- RaoVSP-Human Resource Management, Text, and Cases (ExcelBooks,2"dEd.)

Marketing Management (MS4112)

Objective: To teach the basics of Marketing Management to students from Different streams.

Course Outcome

Students will be able to

- Learn Practical world of Business Environment.
- Analyse and develop effective marketing strategies for various products and services by understanding key concepts like segmentation, targeting, positioning, and the marketing mix.
- Use consumer behavior insights to drive marketing decisions and apply strategic decision-making skills across different stages of the product lifecycle.
- Implement practical pricing, distribution, promotion, and CRM solutions in domestic and international markets.

Introduction

Introduction to Marketing, Marketing Environment.

Market Segmentation

Market Segmentation, Market Targeting- Introduction, Procedure.

Product Positioning

Product Positioning, Consumer Behavior Marketing Mix Decisions, New Product Development. Branding & Packaging Decisions, Product Life cycles.

Pricing Decisions

Pricing Decisions, Management of Channels, Retail Distribution system in India. Promotion Mix, Marketing of Services, Rural Marketing, CRM, Electronic Marketing, International Marketing.

References Book

- Kotler Philip, Keller Kevin Lane, Koshy Abraham & JHA Mithileshwar- - Marketing Management: A south Asian Perspective (Pear sons Education 12th Edition).

Database Management Systems (MS4113)

Objective: To understand the role of a database management system and its users in an organization

Course Outcome

Students will be able to

- Understand the architecture and components of DBMS.
- Design relational databases and develop Entity-Relationship (ER) diagrams.
- Normalize databases to improve efficiency and eliminate redundancy.
- Understand database security, transaction management, recovery techniques.

Introduction to DBMS and Database Models

Definition and purpose of DBMS, Database concepts: Data, information, and knowledge, DBMS vs. file-based systems, Types of database models: Hierarchical, network, and relational database.

Relational Database Design and ER Modeling

The Relational Model: Tables (relations), attributes, tuples, Keys, Entity-Relationship (ER) model: Entities, attributes, and relationships, Mapping ER models to relational schemas, Integrity constraints: Domain, referential, and entity integrity.

Structured Query Language (SQL) and Query optimization

Basic SQL: Creating, modifying, and deleting tables, Querying data using SELECT, WHERE, and basic JOIN operations, Aggregate functions, Creating and managing indexes, Query optimization techniques: Cost-based optimization, query execution plans.

Normalization and Database Design

Redundancy and anomalies in database design, Normal forms: 1NF, 2NF, 3NF, and BCNF, Functional dependencies and their role in normalization, Denormalization and its impact on database performance, Case studies in database design.

Transaction Management and Database Security

Concept of transactions: ACID properties, Concurrency control: Lock-based and timestamp-based protocols, Deadlock handling and recovery techniques, Database security: Access control, authentication, and encryption, Backup and recovery in DBMS.

Text Books

- "Database System Concepts", Abraham Silberschatz, Henry F. Korth, and S. Sudarshan, McGraw-Hill Education, 9781260084504
- "Fundamentals of Database Systems" Ramez Elmasri and Shamkant B. Navathe, Pearson, 9780133971248.

Reference Books

- "Database Systems: The Complete Book", Hector Garcia-Molina, Jeffrey D. Ullman, and Jennifer Widom, Pearson Education, 9788131708422.

Entrepreneurship Development (MS4114)

Objective: The objective is multifaceted, aiming to foster a robust environment for the growth and sustainability of new and existing businesses.

Course outcomes

Students will be able to:

- define and explain key concepts related to entrepreneurship, suchas innovation, risk-taking, and opportunity recognition.
- identify viable business opportunities and assess market needs, customer problems, and potential profitability.
- manage finances effectively, including budgeting, cash flow management, and fundraising strategies.
- develop leadership and teamwork skills, as well as learning to lead teams, manage employees, and collaborate.

Introduction to Entrepreneurship

Introduction to Entrepreneurship, Concepts and Overview of Entrepreneurship, Evolution and Growth of Entrepreneurship in India, Role of Entrepreneurship in Economic Development, Entrepreneurial Culture, Entrepreneurial Society, Women & Rural Entrepreneurship.

Theories of Entrepreneurship

Theories and Models of Entrepreneurship, Framework of Entrepreneurship Theories, Models of Entrepreneurship, Emerging Models of Corporate Entrepreneurship. Emerging Trends in Entrepreneurship Development, Entrepreneurial Potential, and Potential Entrepreneurship, Evaluation of Social Entrepreneurship in India. Skill development: development of entrepreneurial skills, including entrepreneurial motivation, entrepreneurship and the Indian social system, entrepreneurial characteristics and skills, entrepreneurial motivation, and the need for achievement.

Text Books

- Entrepreneurship: Theory, Process, and Practice quot; by Donald F. Kuratko
- Entrepreneurial Small Business by Jerome Katz and Richard Green
- The Lean Startup: How Today Entrepreneurs Use Continuous Innovation to Create RadicallySuccessful Businesses by Eric Ries
- New Venture Creation: Entrepreneurship for the 21st Century by Jeffry A. Timmons andStephen Spinelli

Reference

- Kuratko, D. F. (2016). Entrepreneurship: Theory, Process, and Practice (10th ed.). CengageLearning.
- Ries, E. (2011). The Lean Startup: How Today Entrepreneurs Use Continuous Innovation toCreate Radically Successful Businesses; Crown Business.

Strategic Management (MS5201)

Objective: To develop a theoretical and practical understanding of marketing planning and control by exploring current developments in marketing theory and practice

Course outcome
Students will be able to:

- Develop the ability to analyze complex business environments and formulate effective strategies.
- Gain insights into strategic decision-making and its impact on organizational success.
- Understand how to align resources and capabilities with competitive strategies.

Introduction To Strategic Management
Basic Concepts in Strategic Management, Corporate Governance and Social Responsibility, vision and mission, Levels of strategy, Competitive Advantage, Resource allocation

Scanning the Environment
Definition and Importance, Types of Factors (Internal: Organizational structure; External: Economic, political, social, technological, legal), Techniques (SWOT Analysis, Competitive Analysis), Tools (Data analytics, Business intelligence, Social media monitoring), Challenges, Integration into Strategic Decision-Making.

Strategy Formulation
Situation Analysis and Business Strategy, Strategy Formulation: Corporate Strategy, Strategy Formulation: Functional Strategy and Strategic Choice (Aligning functional areas, developing functional strategies, Evaluating strategic options).

Strategy Implementation and Control
Strategy Implementation: Organizing for Action (Roles, Communication, Resource alignment), Staffing and Directing (Recruitment, Leadership, Performance), Evaluation and Control (Metrics, Monitoring, Feedback), Managing Technology and Innovation (Adoption, Efficiency, Change management), Case Analysis Suggestions (Stakeholders, Decisions, Implementation evaluation).

Reference Readings:

- Ansoff, I. (1965). Corporate Strategy. McGraw-Hill.
- David, F. R. (2011). Strategic Management: Concepts and Cases (13th ed.). Pearson.
- Day, G. S., &Reibstein, D. J. (2004). Wharton on Dynamic Competitive Strategy. Wiley.
- Glueck, W. F., & Jauch, L. R. (1984). Business Policy and Strategic Management (5th ed.). McGraw-Hill.
- Kaplan, R. S., & Norton, D. P. (1996). The Balanced Scorecard: Translating Strategy into Action. Harvard Business School Press.

Business Continuity and Disaster Recovery Planning (MS5202)

Objective: The course is designed with an intent to make the students aware about different protocols and technologies prevailing in the industry in the area of risk mitigation

Course Outcome

Students will be able to:

- Understand key principles of risk analysis, threat assessment, and impact management inbusiness continuity.
- Develop and implement effective Business Continuity and Disaster recovery Plans tailored to organizational needs.
- Design and test recovery solutions to minimize downtime and ensure business resilience.
- Utilize modern data protection technologies for backup and recovery.
- Maintain, test, and update BCP and DRP plans to ensure they remain effective and compliant with organizational standards.

Business continuity planning

Introduction to Risk Analysis and Management, Analysis: Impact Analysis, Threat Analysis, Definition of Impact Scenario, Recovery Requirement Documentation, Solution Design, Implementation Testing, Organizational Acceptance

Testing & Verification

Maintenance, Information Update & Testing, Testing & Verification of Technical Solutions, Testing for Failures, Verification of Organizational Recovery Procedure

Disaster Recovery Planning

Business Data Protection, Prevention of Data Loss, Data Backup, Electronic Vaulting, Strategic DRP Solutions, Data Centre Management

Text Books:

- Business Continuity and Disaster Recovery Planning by Michael Gregg, Published onMarch 10, 2009 by Pearson IT Certification.
- CISSP Study Guide, 2nd Edition by Eric Conrad, Joshua Feldman, Seth Misenar.

Reference Books:

- The Disaster Recovery Handbook: A Step-by-Step Plan to Ensure Business Continuity and Protect Vital Operations, Facilities, and Assets by Michael Wallaceand Lawrence Webber, 2nd Edition.
- Business Continuity Management: Global Best Practices by Andrew Hiles, 3rd Edition, Published by Rothstein Publishing.

Digital Transformation (MS5203)

Objective: The course provides the basis for the use of practical tools that the students could apply in their daily future work activities.

Course Outcome

Students will be able to

- Understand digital technologies and the concept of the digital revolution.
- understand the development of new digital tools

Introduction

Digitization and digital transformation, Digital strategies and strategic agility, Development of a compelling digital strategy (ingredients, elements), Foundations and theories to back up and inspire digital strategies.

Models

Digital business models, Importance of the digital revolution, Digitalization trends and their impact on societies, Analysis of the main pillars of digitalization.

Digital tools

The role of data in the digital transformation, Introduction to new digital tools, providing a basic toolkit of quantitative methods, Digital tools to solve real-life problems, Digital transformation and its impact on the organizations.

Services

Digitally enabled services, digital service innovations, Enterprise capabilities, new perspectives and new capabilities, Case studies on digital transformation.

Text Books:

- The Digital Transformation Roadmap: Rebuild Your Organization for Continuous Change, Columbia University Press, David L. Rogers, 2023.
- Driving Digital Strategy: A Guide to Reimagining Your Business, Harvard Business Review Press, Sunil,2020.

Product Management (MS5204)

Objective: The objective of the course is to equip students with the knowledge and skills necessary to effectively define, develop, and launch successful products

Course Outcome

Students will be able to

- learn all basic concepts to introduce innovative new products in the market
- Customer Based Brand Equity model
- launch a product and do branding on applying the concepts learnt

Introduction

Product Management, How Functional and Product Management Differ from Each Other, Functional Manager vs Product Manager, Definition of product management, Product Orientation and Market Orientation, The Process Levels in Product Management.

Product Management

Product Management, Recruitment of Product Managers, Organizational Integration of Product Management, Organization in Strategic Product Management, Organization in Operational Product Management, Assignment to Technical Functions, Special Forms of Organization in Product Management, Often Neglected: Strategic Responsibility

Organization & Strategies

The Function-Oriented Organization, The Product-Oriented Organization, The Market-Oriented Organization, The Regionally Oriented Organization. Product Marketing: Structures, Success Factors, Market Segmentation, Criteria, Strategies, Product Segmentation, Hierarchies, Revenue and Contribution Margin Analysis), Market Matrix, Product Market Coverage Strategies, Product Market Growth Strategies.

Performance

Product and Brand Awareness, Market Segmentation and Product/Brand Image, Performance, Price or Performance Orientation, Product Benefit Analysis, Quality Function Deployment, Practical Applications Price as a Decision Criterion, PPR & CBR. The Use of Strategic Analysis Tools by the Product Manager.

Strategies

Gaining Market Share, Setting the Product Market Goals, Basic strategies in Product Marketing, Overview of the Strategy Elements, Strategy Development Using the Strategic Toolbox, Marketing Mix Strategies, Pricing Strategies, Distribution Strategies, Assortment Strategies, Other Marketing Mix Strategies.

Text Books:

- Product Management, 4th Edition By Donald Lehmann, Russell Winer, Tata McGraw-Hill.
- Product Manager's Handbook The Complete Product Management Resource second edition, Tata McGrail

Baskets (Marketing)

Digital Marketing (MS 5528)

Objective: This course focuses on understanding of digital revolution, technology and new opportunities for digital marketing.

Course Outcomes:
Students will be able to:

- Design and execute effective digital marketing strategies
- Analyse digital marketing performance and leverage SEO, SEM, and social media.
- Plan and manage digital advertising campaigns on different platforms and
- Will understand business and revenue models in the digital space

Introduction to Digital Marketing
Fundamental Marketing Concepts, 7D of digital marketing, RACE concept, Digital audience, Digital device, digital marketing goal and strategy.

Business models
Business model, revenue model, online marketplace, digital branding and marketing mix, types of digital media.

Designs
Website design, CMS platform, and types, social media marketing, content marketing-mail marketing, Google keyword planner, Google trend.

Webs Usage
Google analytics, web analytics, Facebook and LinkedIn analytics, blog site designing, and tracking, Google ad words, campaign planning, cases.

References Book:

- "Digital Marketing: Strategy, Implementation and Practice" by Dave Chaffey and Fiona Ellis-Chadwick
- "E-Marketing" by Judy Strauss, Raymond Frost, and Alexa Fox
- "Digital Marketing Excellence: Planning, Optimizing and Integrating Online Marketing" by Dave Chaffey and PR Smith
- "Understanding Digital Marketing: Marketing Strategies for Engaging the Digital Generation" by Damian Ryan

Consumer Behavior (MS 5534)

Objective: The course deals with the behavioral aspects of marketing management & explain how the markets, consumers behave. It' ll enable students to develop marketing strategies that are consumer based, create & enhance customer value.

Course Outcome

Students will be able to:

- Analyze the behavioral aspects of marketing management.
- Evaluate consumer behavior in various market conditions and examine the influence of various factors on consumerdecision-making.
- Develop consumer-based marketing strategies that enhance customer value and align with organizational objectives.

Consumer behavior

Definition, scope, customer value, Customer satisfaction, Injurious consumption, Traditional marketing concept, Models of Consumer Behavior, Nicosia, Howard sheth, Consumer benefits, and evaluative criteria, Decision Heuristic

Consumer motivation

Needs, Goals, Discovering purchase motives, motivation research, Defense mechanism, Personality, Consumer innovativeness, Dogmatism, Cognitive personality factors, Self-image, Forms, How general personality influence consumer behavior

Consumer learning

Consumer learning and Reference group appeal, Conditioning, , Information Processing, Perceptual mapping, attitude model, Consumerrelated reference groups, Brand communities, decision-making process, Family life cycle, Perception, Figure and ground, grouping, closure, Perceptual distortion, Perceived risk, Perceived quality, Opinion leadership, Surrogate buyer, Adopter categories, Adoption process

Purchasing Process and Post purchase behavior

Store location, Store design,and Physical facilities, Store specific shopper profiles In-store purchasing behavior, Usage segmentation, Brand user, Product user, Loyalty, situation segmentation, Positive/ negative Post purchase Behaviour, Complaint Behaviour

Reference Book:

- Jay D. Lindquist, M. Joseph Sirgy, Shopper, buyer and Consumer Behavior, Bertantra, New Delhi, 2007.
- Del 1. Hawkins, Roger J, Best, Kenneth A. Coney, Amit Mookerjee, Consumer Behavior Building Marketing Strategy, 9/e, Tata McGraw-Hill, New Delhi, 2007,
- Leon G.Schiffinan, Kanuk Leslie Lazar, Consumer behavior, PII Learning, New Delhi, 2008.
- David L. Loudon, Albert J. Della Bitta, Tata McGraw-Hill, New Delhi, 2007

Marketing Research (MS 5535)

Objective: The course objectives of Marketing Research typically include understanding the marketing research process, identifying consumer needs and preferences

Course Outcomes:
Students will be able to:

- Understand theoretical and practical knowledge of marketing research methods, enabling them to design, execute, and analyze research projects.
- get data collection and analysis techniques and can apply various tools and statistical methods to solve real-world marketing problems.
- Ethical considerations and effective communication of research results will be central skills developed throughout the course, preparing students for careers in market research, consultancy, or strategic organizational roles.

Introduction
Introduction and Early Phases of Marketing Research; Marketing problem, Marketing research, Research approach; Research Design Formulation (Exploratory, causal, longitudinal, Questionnaires, survey); Primary and Secondary data

Scales
Scales, Questionnaire design; Sampling

Analysis
Statistical analysis- Manova, Anova, Cluster Analysis, Sentiment analysis, Conjoint analysis, R programming and xlstat.

Research
Mobile research, Internet Research, Ethics, Ethical regulations; Research report writing, presentation and discussion

References Book

- "Marketing Research: An Applied Orientation" by Naresh K. Malhotra
- "Essentials of Marketing Research" by William G. Zikmund, Barry J. Babin, Jon C. Carr, and Mitch Griffin
- "Marketing Research" by Aaker, Kumar, Day, and Leone
- "Marketing Research: Methodological Foundations" by Gilbert A. Churchill and Dawn Iacobucci
- "The Market Research Toolbox: A Concise Guide for Beginners" by Edward F. McQuarrie

Data-Driven Marketing (MS 5536)

Objective: To understand the concept of delivery channels, as well as creative content that is appropriate to each, in order to establish and grow relationships that benefit marketer and consumer alike.

Course outcome
Students will be able to:

- Analyze and interpret customer data to inform strategic marketing decisions.
- Utilize data analytics tools to optimize and measure performance.
- Develop personalized marketing strategies based on consumer insights and behavioral patterns and understand the ethical considerations and best practices.

Data-Driven Models: An Overview
Identifying what to measure, the descriptive, diagnostic, predictive, and prescriptive approach DDM, The classical marketing metrics, the essential financial metrics.

Optimizing Marketing Strategies
Identifying the marketing process, Establishing key customer/consumer touchpoints, Modeling, Model optimization and reinforcement, Developing logic and decision scenarios.

Harnessing Data for Marketing strategy
The modern metrics, Web auditing, SEO&SERP, Social sentiment & click economy, AI & new age marketing communication.

Navigating the Dataset
Leaders & laggards: Barriers to Data-Driven Marketing, UX, CX & Data, Extracting, Exploring, and Understanding the Dataset

Reference readings:

- McDougall, J. S. (2012). #Tweetsmart.
- Semmelroth, D. (2013). Data-driven marketing for dummies.
- Bryan, R. (2017). Data-driven marketing.
- Jeffery, M. (2010). Data-driven marketing: The 15 metrics everyone in marketing should know.
- Sponder, M. (2018). Digital analytics for marketing.
- Holdren, A. (2020). Google AdWords.
- Croll, A. (2018). Lean analytics.
- Busche, L. (2017). Lean branding.
- Chaters, B. (2018). Mastering search analytics.
- Ward, A. A. (2017). SEO battlefield.
- Jerkovic, J. I. (2015). SEO warrior.
- Zarrella, D. (2019). The social media marketing book.

Baskets (HR)

Creativity and Innovation (MS 5540)

Objective: To let the students understand the importance of creativity and innovation in organizations.

Course Outcomes
Students will be able to:

- Develop a deep understanding of the foundational concepts, theories, and models of creativity and innovation in a business context and will demonstrate the ability to generate innovative and creative solutions to complex business problems.
- Gain skills to cultivate and lead an organizational culture that promotes creativity, risk-taking, and continuous innovation.
- Integrate innovation into business strategies and understand how creative thinking can enhance leadership effectiveness and decision-making, driving competitive advantage in dynamic business environments.

Managing Creativity
An Overview, Understanding Creativity, Difference Between Creativity, Invention, and Innovation, Types of Innovation, Theories of Creativity, Challenges and Barriers to Creativity in Organizations.

Unblocking Creative Potential
Ideation Techniques**,** Creative Problem-Solving Frameworks,Enhancing Personal Creative Abilities, Creativity in Leadership and Decision-Making

Organizational Creativity and Innovation Culture
Building an Innovation-Friendly Culture, Encouraging Risk-Taking and Learning from Failure, Role of Leaders in Fostering Creativity and Innovation, Creativity Techniques (Brainstorming, lateral Thinking, Forced Relationship, Morphological Analysis, Attribute Listing.)

Managing Creativity in Organization
Integrating Innovation into Business Strategy, Product, Process, and Business Model Innovation, Innovation Ecosystems and Open Innovation

Text Books

- “Creativity and Innovation: The ASTD Trainer's Sourcebook”, Elaine Biech, First Edition, 1996, McGraw Hill Education, ISBN 978-0070534452.
- “Corporate Creativity: How Innovation and Improvement Actually Happen”, Alan G. Robinson, Sam Stern, First Edition, 1997, Berrett-Koehler Publishers, ISBN 978-1576750094.

Reference Books

- “Harvard Business Essentials: Guide to Managing Creativity and Innovation”, Harvard Business Essentials, First Edition, 2011, Harvard Business School Press,ISBN 978-1591391128

Baskets (Financial Management)

Financial Technology (MS 5506)

Objective: The objective is to equip students with the knowledge and skills necessary to Identify potential threats and evaluate the potential impact of disruptions on critical business functions, identifying priorities and dependencies.

Course Outcomes

Students will be able to :

- Appreciate how technology is reshaping financial services and will understand key Fintech sectors and their impact on traditional financial institutions.
- Evaluate the business models and strategies employed by Fintech firms and will understand global FinTech landscape
- Get familiar with competitive landscape of FinTech startups in payments, lending, banking, capital markets & insurance.

Introduction to the Fintech landscape

Overview of Fintech and its importance in the financial services industry, Traditional vs. Fintech models of finance, the Fintech ecosystem: startups, regulators, and financial institutions, BFSI Value chain, How FinTech changed BFSI, FinTech Architecture, FinTech Technologies, Latest Trends and future of FinTech, Fintech startups

Blockchain Technology and DeFi

Blockchain Foundations, Blockchain in Use, Smart contracts, Cryptocurrencies Primer, Bitcoin and Applications, Cryptocurrencies and Digital Crypto Wallets, Types of Cryptocurrencies, Cryptocurrencies and Business use cases in supply chain, contracts, and record-keeping, Stable coins, Decentralized Finance (DeFi) and its impact, DeFi Platforms, Decentralized Exchanges

Digital Payments, Peer-to-Peer Lending & Crowdfunding

Global Payment Ecosystem, Payments Architecture and Setup, Innovation in Consumer and Retail payments, Popular Payments Technology, Concept of P2P Lending, P2P and Marketplace Lending, Crowd funding: Models and platforms.

Emerging Technologies and Innovations in Fintech

Banktech, Insurtech, Regtech, Algorithmic Trading, Robo-Advisory, Cybersecurity and Fraud Prevention in Fintech, Fintech Regulation and Compliance, Future Trends in Fintech

Reference Books:

- “Financial Technology: Case studies in fintech innovation”, Niels Pedersen, Kogan Page Ltd., 978178966 5451.
- “Disrupting Finance: FinTech and Strategy in the 21st Century”. Theo Lynn, John G. Mooney, Pierangelo Rosati, Mark Cummins, Palmgrave Macmillan, 978-3-030-02329-4
- “Harvard Business Review: Crypto”, Harvard Business Review Publishing, 9781647824495.

Financial derivatives and Risk Management (MS 5507)

Objective: The main aim of this course is to familiarize students with the concepts of financial derivatives

Course Outcomes

Students will be able to:

- Understand derivatives in details and will demonstrate critical thinking, analytical and problem-solving skills in the context of derivatives pricing and hedging practice
- help in analyzing various risk in business environment particularly in derivatives products and to generate an optimal risk management strategy.
- get expose in evaluating risks in terms of frequency and severity

Introduction

Introduction to derivatives instruments: futures, forwards Commodity Futures, Swaps, Options

Derivatives

Derivative mechanics and strategies, Greeks Option Pricing: Binomial Model, Black-Scholes-Merton Model

Risk

Identify and describe risk in the business environment; Credit risk, market risk, operational risk, liquidity risk, legal risk, interest rate risk and currency risk; Risk Measurement; Risk preferences. Risk premium, Risk attitudes, Value at Risk, Stress testing and scenario Analysis; Risk transfer; Risk Management Method in Business

Text Book:

- Options Futures & Other Derivatives by Hull, John, C.; Global Edition, Pearson Education.
- Fundamentals of Futures and Options Markets Paperback by C. Hull John.

References:

- Hull, John, C., “Risk Management & Financial Institutions”, Wiley Finance.
- Neftci, Salih, N. “Principles of Financial Engineering” , Academic Press.
- Cuthbertson, Keith & Nitzsche, Dirk, “Financial Engineering: Derivatives & Risk Management” John Wiley.
- Saunders, Anthony & Cornett, Marcia Millon, “Financial Institutions Management: A Risk Management Approach” McGraw Hill/Irwin.
- Marshall, John, F & Bansal, Vipul, “Financial Engineering” PHI Learning.

Baskets (IT)

Search Engine Optimization (MS 5522)

Objective: The course objectives focus on teaching students how to improve a website's visibility on search engines like Google by understanding search engine algorithms, utilizing relevant keywords, optimizing website structure,

Course Outcomes

Students will be able to

- Understand the fundamentals of search engine algorithms and ranking factors.
- Analyze website performance using SEO tools and data analytics.
- Develop and execute SEO strategies that align with business goals and marketing campaigns.

Search Fundamentals

How search engines work, language of search, Crawling, indexing and their types, ranking and ranking factors.What is SEO? The importance of organic search. SEO planning and the business of SEO.

Keyword Research

Starting SEO**,** The role of keywords in SEO, Types of keywords: Short-tail vs. long-tail keywords,Keyword research tools, Creating a keyword strategy: Relevance, competition, and search volume. Internal and External resources for keyword research, keyword valuation.

On-Page and Off-PageSEO Optimization

Optimizing meta tags ,Content, image optimization, URL structure and internal linking best practices, subdomains and subfolders, duplicate content, redirects, schema, sitemaps, Introduction to off-page SEO, Quality backlinks, guest blogging, influencer outreach, Social signals and their impact on SEO.Content Management Systems.

SEO Analytics and SEO Auditing

CMS Selection, Introduction to SEO tools, Tracking and analyzing website performance, Setting up KPIs and monitoring SEO success, Conducting an SEO audit and improving site performance, Approaches to SEO auditing, audit checklist, content auditing.

Strategic SEO Approaches and Future Trends

Mobile, local and Vertical SEO, Developing a long-term SEO strategy.Ethical SEO vs. Black Hat SEO:The future of SEO: AI, voice search, and the evolving search landscape.

Reference Books:

- “The Art of SEO”, Eric Enge, Stephan Spencer, and Jessie Stricchiola, O’Reilly Media, Inc, 978-1-098-10261-6.
- “Search Engine Optimization Bible”, Jerri L. Ledford, Wiley Publishing,978-0-470-17500-
- “SEO 2022Learn Search Engine Optimization with Smart Internet Marketing Strategies”Adam Clarke, Simple Effectiveness LLC, 9780578333380.

Data Mining and Warehousing (MS 5548)

Objective: The course deals with understanding of various Data pre-processing techniques and data quality and Understanding of Big Data and Business Intelligence

Course Outcomes
Students will be able to:

- Build and manage a data warehouse effectively and use reporting tools, OLAP systems, and applications for business decision-making and analysis.
- Understand data types, mining functionalities, and the process of integrating data mining with a data warehouse
- Understand various clustering techniques, analyze data trends, and apply data mining in real-world scenarios

Data warehousing Components
Building a Data warehouse, Mapping the Data Warehouse to a Multiprocessor Architecture, DBMS Schemas for Decision Support, Data Extraction, Cleanup, and Transformation Tools, Metadata

Business analysis
Reporting and Query tools and Applications, Tool Categories, Cognos Impromptu, Online Analytical Processing, Multidimensional Data Model, OLAP Guidelines, Multidimensional versus Multi Relational OLAP, Categories of Tools, OLAP Tools and the Internet.

Data mining and Association rule mining & classification
Data, Mining Functionalities, Patterns, Classification, Primitives, with a Data Warehouse, Issues, Data Preprocessing. Mining Frequent Patterns, Mining Methods, asociation Rules, Correlation Analysis, Constraint Based Association Mining, Classification and Prediction, Decision Tree, Induction, Bayesian Classification, Rule Based Classification, Classification by Back propagation, SVM Associative Classification, Lazy Learners, Other Classification Methods, Prediction.

Clustering and applications and trends in data mining
Cluster Analysis, Types of Data, Categorization of Major Clustering Methods, Kmeans, Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid, Based Methods, Model-Based Clustering Methods, Clustering High Dimensional Data. Constraint Based Cluster Analysis. Outlier Analysis, Data Mining Applications.

Reference Book:

- Alex Berson and Stephen J. Smith, Data Warehousing, Data Mining & OLAP", Tata McGraw-Hill Edition, Tenth Reprint 2007.
- Jiawei Han and Micheline Kamber. "Data Mining Concepts and Techniques", Second Edition, Elsevier, 2007.
- Pang-Ning Tan, Michael Steinbach and Vipin Kumar, "Introduction To Data Mining", Pearson Education, 2007.

Baskets (Operation management)

Total Quality Management and Six Sigma (MS 5513)

Objective: The overall purpose of the course is to provide an understanding of the process of managing quality and managing services

Course Outcomes
Students shall be able to:

- Understand the Total Quality Management concept and principles, statistical approach to quality control.
- Create awareness about the ISO and QS certification process and develop models for complex problems in business situations
- Learn various algorithms for solving operations problems

Introduction
Definition of Quality, Dimensions, Planning, costs, TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

TQM Principles & Quality Improvement Techniques
Customer satisfaction, perception, Complaints, Service, Quality, Customer Retention, Employee Involvement, Continuous Process improvement, Supplier Partnership, Performance Measures, Pareto Diagrams, Cause-Effect Diagrams, Scatter Diagrams, Run Charts, Cause and Effect Diagrams

Statistical Process Control
Statistical Quality Control,Sources of Variation, Descriptive Statistics,Statistical Process Control Method, Control Chart for Variables, Control Chart for Attributes, C Charts, Proc ess Capability, Developing OC Curve, Average Outgoing Quality

TQM Tools, Quality Systems and Six Sigma
Benchmarking, Quality Function, Deployment, House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance, FMEA – Stages of FMEA, ISO 9000,Other Quality Systems,ISO 9000:2000 QualitySystem,Quality Auditing, TS16 949, ISO 14000, Six Sigma definition, goals, comparrision, methodology – DMAIC & IDOV, Important Concepts of Six Sigma

Text Books:

- Dale H.Besterfiled, et al., “Total Quality Management”, Pearson Education, Inc.2003. (Indian reprint 2004). ISBN 81-297-0260-6.
- James R.Evans & William M.Lidsay, “The Management and Control of Quality”, (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06680-5).

Reference Books:

- Feigenbaum.A.V. “Total Quality Management”, McGraw-Hill, 1991.
- Total Quality Management by N.V.R Naidu, G. Rajendra New Age international, First Edition, Jan 2006
- Total Quality Management by R.S Naagarazan ,New Age international,3e, 2015