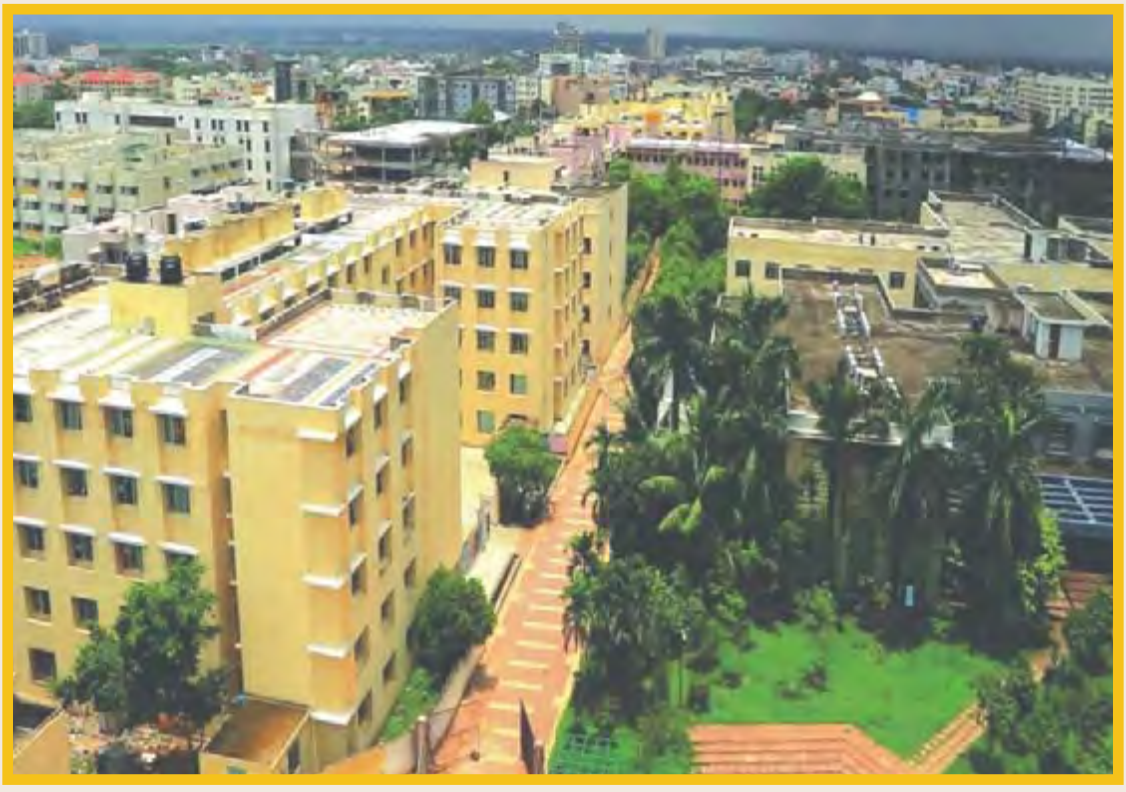
ACADEMIC CURRICULA 2014 - 2016

MASTER'S DEGREE PROGRAMME

M.Tech

Curricula & Syllabi



KIIT UNIVERSITY
(Declared U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

ACADEMIC CURRICULA

2014 - 2016

MASTER'S DEGREE PROGRAMME

M.Tech

Course Structure and Detailed Syllabi
for students admitted during
Session 2014-15

KIIT UNIVERSITY
(Declared U/S 3 of UGC Act, 1956)
Bhubaneswar, Odisha, India

SCHOOL OF CIVIL ENGINEERING
SPECIALIZATION: CONSTRUCTION ENGINEERING AND MANAGEMENT

SEMESTER-I

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	CE6101	Project Planning and Control	3	1	0	4
2	CE6103	Construction Finance Management	3	0	0	3
3	CE6105	Material Technology	3	1	0	4
4	CE6107	Quantitative Methods in Construction Management	3	0	0	3
5	CE6109	Building Science	3	1	0	4
Total Theory						**18**
Practical						
1	CE6191	Material Testing Lab.-I	0	0	3	2
2	CE6193	Computer Application Lab	0	0	3	2
Sessional						
1.	CE6181	Seminar	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**23**

SEMESTER-II

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hour per Week**			**Credit**
			L	**T**	**P**	
1	CE6102	Construction Engineering Practices	3	0	0	3
2	CE6104	Advanced Construction Materials	3	1	0	4
3	CE6106	Construction Methods & Equipments	3	1	0	4
4		Elective-I	3	0	0	3
5		Elective-II	3	0	0	3
Total Theory						**17**
Practical						
1	CE6192	Materials Testing Lab -II	0	0	3	2
Sessional						
1	CE6182	Seminar	0	0	2	1
2	CE6184	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**5**
Semester Total						**22**

SEMESTER-III

Sl.No	Subject Code	Subject Name	Credit
1	CE6187	**Thesis Part-I**	**15**

SEMESTER-IV

Sl.No	Subject Code	Subject Name	Credit
1	CE6188	**Thesis Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

ELECTIVE - I & II

Sl.No.	Subject Code	Subject Name	Credit
1.	CE6132	System Design and Value Analysis	3
2.	CE6134	Project quality and Safety Management	3
3.	CE6136	Building Services Planning	3
4.	CE6138	Advanced Repairs and Rehabilitation of Structures	3
5.	CE6142	Contract Laws and Regulations	3
6.	CE6144	Foundation Engineering	3
7.	CE6146	Quality Control in Construction	3

SCHOOL OF CIVIL ENGINEERING
SPECIALIZATION: STRUCTURAL ENGINEERING

SEMESTER-I

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	CE6201	Advanced Structural Analysis	3	1	0	4
2	CE6203	Theory of Elasticity and Plasticity	3	0	0	3
3	CE6205	Numerical Methods in Civil Engineering	3	0	0	3
4	CE6105	Material Technology	3	1	0	4
5		Elective-I	3	0	0	3
Total Theory						**17**
Practical						
1	CE6291	Structural Engineering Lab	0	0	3	2
2	CE6293	Computational Lab–I	0	0	3	2
Sessional						
1	CE6281	Seminar	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**22**

SEMESTER-II

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hour per Week**			**Credit**
			L	**T**	**P**	
1	CE6202	Advanced Steel Design	3	1	0	4
2	CE6204	Advanced Reinforced Concrete Design	3	1	0	4
3	CE6206	Structural Dynamics and Earthquake Engg.	3	1	0	4
4	CE6208	Stability Of Structures	3	0	0	3
5		Elective-II	3	0	0	3
Total Theory						**18**
Practical						
1	CE6292	Computational Lab-II	0	0	3	2
Sessional						
1	CE6282	Seminar	0	0	2	1
2	CE6284	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**5**
Semester Total						**23**

SEMESTER-III

Sl.No	Subject Code	Subject Name	Credit
1	CE6287	**Thesis Part-I**	**15**

SEMESTER-IV

Sl.No	Subject Code	Subject Name	Credit
1	CE6288	**Thesis Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

Sl.No.	Subject Code	Subject Name	Credit
1.	CE6231	Finite Element Methods	3
2.	CE6233	Theory of Plate and Shells	3
3.	CE6235	Advanced Foundation Engineering	3
4.	CE6237	Construction Planning & Management	3
5.	CE6239	Composite Structures	3

Dept. Elective - II

1.	CE6232	Design of Bridges	3
2.	CE6234	Pre-stressed Concrete	3
3.	CE6236	Design of Industrial Structures	3
4.	CE6238	Design of Offshore Structure	3
5.	CE6242	Soil-Structure Interaction	3
6.	CE6244	Optimization Techniques	3

SCHOOL OF COMPUTER ENGINEERING
SPECIALIZATION: COMPUTER ENGINEERING

SEMESTER - I

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	T	P	
1	MA-6001	Advanced Mathematics	3	1	0	4
2	CS-6101	Algorithm & Complexity Analysis	3	1	0	4
3	CS-6201	Cryptography	3	1	0	4
4	CS-6301	Data Mining and Data Warehousing	3	1	0	4
5		Elective – I	3	0	0	3
Total Theory						**19**
Practical						
1	CS-6191	Computing Lab	0	0	3	2
2	CS-6391	Data Mining & Data Warehousing Lab	0	0	3	2
Sessional						
1	CS-6181	Seminar	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**24**

SEMESTER - II

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hour per Week**			**Credit**
			L	T	P	
1	CS-6102	Computational Intelligence	3	1	0	4
2	CS-6302	Big Data Analytics	3	1	0	4
3	CS-6104	Mobile Communication & Computing	3	1	0	4
4		Elective – II	3	0	0	3
5		Elective – III	3	0	0	3
Total Theory						**18**
Practical						
1	CS-6192	Computational Intelligence Lab	0	0	3	2
Sessional						
1	CS-6182	Seminar	0	0	2	1
2	CS-6184	Comprehensive Viva Voce	0	0	2	2
Total Practical & Sessional						**5**
Semester Total						**23**

SEMESTER - III

Sl.No	Subject Code	Subject Name	Credit
1	CS-6187	**Thesis Part-I**	**15**

SEMESTER - IV

Sl.No	Subject Code	Subject Name	Credit
1	CS-6188	**Thesis Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

Sl. No	Subject Code	Subject Name	Credit
1.	CS-6121	Advanced Computer Architecture	3
2.	CS-6123	Distributed Computing	3
3.	CS-6125	Image Processing	3
4.	CS-6421	Software Design Pattern	3

Dept. Elective - II & III

Sl. No	Subject Code	Subject Name	Credit
1.	CS-6122	Cloud Infrastructure & Services	3
2.	CS-6124	Service Oriented Architecture	3
3.	CS-6126	Embedded Systems	3
4.	CS-6128	Pattern Recognition	3
5.	CS-6132	Geographical Information System	3
6.	CS-6134	Machine Learning	3
7.	CS-6228	Performance Evaluation of Information Systems	3
8.	CS-6422	Software Project Management	3

SCHOOL OF COMPUTER ENGINEERING
SPECIALIZATION: INFORMATION SECURITY

SEMESTER - I

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	MA-6001	Advanced Mathematics	3	1	0	4
2	CS-6101	Algorithm & Complexity Analysis	3	1	0	4
3	CS-6201	Cryptography	3	1	0	4
4	CS-6203	Information Theory & Coding Techniques	3	1	0	4
5		Elective I	3	0	0	3
Total Theory						**19**
Practical						
1	CS-6291	Information Security Lab	0	0	3	2
2	CS-6191	Computing Lab	0	0	3	2
Sessional						
1	CS-6281	Seminar	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**24**

SEMESTER - II

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	CS-6102	Computational Intelligence	3	1	0	4
2	CS-6302	Big Data Analytics	3	1	0	4
3	CS-6202	Cyber Law & Security Policy	3	1	0	4
4		Elective – II	3	0	0	3
5		Elective – III	3	0	0	3
Total Theory						**18**
Practical						
1	CS-6192	Computational Intelligence Lab	0	0	3	2
Sessional						
1	CS-6284	Comprehensive Viva Voce	-	-	-	2
2	CS-6282	Seminar	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**23**

SEMESTER-III

Sl.No	Subject Code	Subject Name	Credit
1	CS-6287	**Thesis Part-I**	**15**

SEMESTER-IV

Sl.No	Subject Code	Subject Name	Credit
1	CS-6288	**Thesis Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

Sl. No	Subject Code	Subject Name	Credit
1.	CS-6221	Data & Knowledge Security	3
2.	CS-6223	Intrusion Detection System	3
3.	CS-6225	Digital Forensics	3

Dept. Elective - II & III

1.	CS-6222	Mobile Wireless Security	3
2.	CS-6224	Biometric Security	3
3.	CS-6226	Steganography and Digital Water Marking	3
4.	CS-6228	Performance Evaluation of Information Systems	3

SCHOOL OF COMPUTER ENGINEERING
SPECIALIZATION: DATA ANALYTICS

SEMESTER - I

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	MA-6001	Advanced Mathematics	3	1	0	4
2	CS-6101	Algorithm & Complexity Analysis	3	1	0	4
3	CS-6201	Cryptography	3	1	0	4
4	CS-6303	Database Design	3	1	0	4
5		Elective – I	3	0	0	3
Total Theory						**19**
Practical						
6	CS-6191	Computing Lab	0	0	3	2
7	CS-6393	Advanced Database Lab	0	0	3	2
Sessional						
8	CS-6381	Seminar	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**24**

SEMESTER - II

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	CS-6102	Computational Intelligence	3	1	0	4
2	CS-6302	Big Data Analytics	3	1	0	4
3	CS-6301	Data Mining and Data Warehousing	3	1	0	4
4		Elective – II	3	0	0	3
5		Elective – III	3	0	0	3
Total Theory						**18**
Practical						
6	CS-6391	Data Mining and Data Warehousing Lab	0	0	3	2
Sessional						
7	CS-6382	Seminar	0	0	2	1
8	CS-6384	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**5**
Semester Total						**23**

SEMESTER - III

Sl.No	Subject Code	Subject Name	Credit
1	CS-6387	**Thesis Part-I**	**15**

SEMESTER - IV

Sl.No	Subject Code	Subject Name	Credit
1	CS-6388	**Thesis Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

Sl. No	Subject Code	Subject Name	Credit
1	CS-6321	Information Storage & Management	3
2	CS-6323	M-Commerce	3
3	CS-6325	Information Retrieval	3
4	CS-6327	Enterprise Systems	3

Dept. Elective - II & III

Sl. No	Subject Code	Subject Name	Credit
1	CS-6122	Cloud Infrastructure and Services	3
2	CS-6221	Data & Knowledge Security	3
3	CS-6228	Performance Evaluation of Information Systems	3
4	CS-6322	Knowledge Representation & Reasoning	3
5	CS-6324	Distributed & Parallel Databases	3
6	CS-6326	Database Implementation & Tuning	3
7	CS-6328	Decision Support Systems	3
8	CS-6332	Geospatial Data Management	3
9	CS-6334	Business Analytics and Intelligence	3
10	CS-6336	Graph Theory and Applications	3

SCHOOL OF COMPUTER ENGINEERING
SPECIALIZATION: SOFTWARE ENGINEERING

SEMESTER - I

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	T	P	
1	MA-6001	Advanced Mathematics	3	1	0	4
2	CS-6101	Algorithm & Complexity Analysis	3	1	0	4
3	CS-6201	Cryptography	3	1	0	4
4	CS-6401	Software Requirement Engg.	3	1	0	4
5		Elective – I	3	0	0	3
Total Theory						**19**
Practical						
1	CS-6191	Computing Lab	0	0	3	2
2	CS-6491	Software Design Lab	0	0	3	2
Sessional						
1	CS-6481	Seminar	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**24**

SEMESTER-II

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hour per Week**			**Credit**
			L	T	P	
1	CS-6102	Computational Intelligence	3	1	0	4
2	CS-6302	Big Data Analytics	3	1	0	4
3	CS-6402	Software Testing	3	1	0	4
4		Elective – II	3	0	0	3
5		Elective – III	3	0	0	3
Total Theory						**18**
Practical						
1	CS-6492	Software Testing Lab	0	0	3	2
Sessional						
1	CS-6482	Seminar	0	0	2	1
2	CS-6484	Comprehensive viva voce	-	-	-	2
Total Practical & Sessional						**5**
Semester Total						**23**

SEMESTER-III

Sl.No	Subject Code	Subject Name	Credit
1	CS-6487	**Thesis Part-I**	**15**

SEMESTER-IV

Sl.No	Subject Code	Subject Name	Credit
1	CS-6488	**Thesis Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

Sl. No	Subject Code	Subject Name	Credit
1.	CS-6421	Software Design Pattern	3
2.	CS-6423	Software Architecture	3

Dept. Elective - II & III

Sl. No	Subject Code	Subject Name	Credit
1.	CS-6122	Cloud Infrastructure & Services	3
2.	CS-6124	Service Oriented Architecture	3
3.	CS-6228	Performance Evaluation of Information Systems	3
4.	CS-6322	Knowledge Representation & Reasoning	3
5.	CS-6422	Software Project Management	3
6,	CS-6424	Software Engineering Process & Quality	3
7.	CS-6426	Software Reliability	3
8.	CS-6428	SW Maintenance & Configuration Management	3
9.	CS-6432	Software Metrics	3

SCHOOL OF ELECTRICAL ENGINEERING
SPECIALIZATION: POWER AND ENERGY SYSTEM

SEMESTER-I

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1.	EE6101	Power System Dynamics	3	1	0	4
2.	EE6103	Advanced Renewable Energy Systems	3	0	0	3
3.	EE6207	Power Electronics & Drives	3	0	0	3
4.		Department Elective -I	3	0	0	3
5.		Department Elective - II	3	0	0	3
Total Theory						**16**
Practical						
1.	EE6191	Power System Laboratory - I	0	0	3	2
2.	EE6193	Modeling and Simulation Laboratory	0	0	3	2
3.	EE6195	Energy System Laboratory	0	0	3	2
Sessional						
1.	EE6181	Seminar	0	0	2	1
Total Practical & Sessional						**7**
Total of Semester						**23**

SEMESTER-II

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1.	EE6102	Power System Restructuring	3	1	0	4
2.	EE6104	Electrical Energy Systems and Management	3	1	0	4
3.	EE6106	Advanced Control System	3	0	0	3
4.		Department Elective -III	3	0	0	3
5.		Department Elective - IV	3	0	0	3
Total Theory						**17**
Practical						
1.	EE6192	Power System Laboratory – II	0	0	3	2
2.	EE6194	Power Electronics & Control Lab	0	0	3	2
Sessional						
1.	EE6182	Seminar	0	0	2	1
2.	EE6184	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**7**
Total of Semester						**24**

SEMESTER-III

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6187	**Thesis – Part -I**	**15**

SEMESTER-IV

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6188	**Thesis – Part -II**	**20**

LIST OF DEPARTMENT ELECTIVES

Elective- I

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6121	Computer Application in Power System	3
2.	EE6123	Power Market Reforms	3
3.	EE6125	Safety and Reliability of Power Systems	3
4.	EE6223	Advanced Microprocessors & Applications	3

Elective- 1I

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6131	Power Quality Assessment & Mitigation	3
2.	EE6133	Advanced Electrical Engineering Materials	3
3.	EE6135	Energy Instrumentation	3
4.	EE6137	Advanced Energy Conversion System	3
5.	EE6139	Illumination Engineering	3

Elective- III

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6122	Computational Intelligent controllers	3
2.	EE6124	HVDC and FACTS	3
3.	EE6126	Advanced Power System Protection	3
4.	EE6128	Power System Transients	3

Elective- IV

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6132	Solar Power Engineering	3
2.	EE6134	Bio-Power Engineering	3
3.	EE6136	Wind Power Engineering	3
4.	EE6138	Energy Management and Audit	3
5.	EE6140	Energy and Environmental Impact Analysis	3

SCHOOL OF ELECTRICAL ENGINEERING
SPECIALIZATION: POWER ELECTRONICS & DRIVES

SEMESTER-I

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1.	EE6201	Generalized theory of Electrical Machine	3	1	0	4
2.	EE6203	Power Electronics Converter-I	3	1	0	4
3.	EE6205	Electric Drive System	3	1	0	4
4.		Department Elective -I	3	0	0	3
5.		Department Elective - II	3	0	0	3
Total Theory						**18**
Practical						
1.	EE6291	Power Electronics Converter Lab	0	0	3	2
2.	EE6293	Electrical Machine & Power System Lab	0	0	3	2
Sessional						
1.	EE6281	Seminar	0	0	2	1
2.	EE6283	Design of Power Electronics System	0	0	3	2
Total Practical & Sessional						**7**
Total of Semester						**25**

SEMESTER-II

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1.	EE6202	Advanced Electric Drives	3	1	0	4
2.	EE6204	Power Electronics Converter-II	3	1	0	4
3.	EE6106	Advanced Control System	3	0	0	3
4.		Department Elective - III	3	0	0	3
5.		Department Elective - IV	3	0	0	3
Total Theory						**17**
Practical						
1.	EE6292	Power Electronics & Drives Lab	0	0	3	2
2.	EE6294	Power Electronics Modelling and Simulation Lab	0	0	3	2
Sessional						
1.	EE6282	Seminar	0	0	2	1
2.	EE6284	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**7**
Total of Semester						**24**

SEMESTER-III

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6287	**Thesis – Part -I**	**15**

SEMESTER-IV

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6288	**Thesis – Part -II**	**20**

LIST OF DEPARTMENT ELECTIVES

Elective- I

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6221	Industrial Instrumentation and Transducers	3
2.	EE6223	Advanced Microprocessors & Applications	3
3.	EE6121	Computer Application in Power System	3
4.	EE6133	Advanced Electrical Engineering Materials	3

Elective- II

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6231	Power Semiconductor devices	3
2.	EE6233	Advanced Digital Signal processing	3
3.	EE6131	Power Quality Assessment & Mitigation	3
4.	EE6103	Advanced Renewable Energy Systems	3

Elective- III

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6222	Dynamics of Power Electronics Converter	3
2.	EE6122	Computational Intelligent controllers	3
3.	EE6124	HVDC and FACTS	3
4.	EE6126	Advanced Power System Protection	3

Elective- IV

Sl. No.	Subject Code	Subject Name	Credit
1.	EE6232	Traction and Hybrid Electric Vehicle	3
2.	EE6132	Solar Power Engineering	3
3.	EE6136	Wind Power Engineering	3
4.	EE6138	Energy Management and Audit	3

SCHOOL OF ELECTRONICS ENGINEERING
SPECIALIZATION: COMMUNICATION SYSTEM ENGINEERING

SEMESTER - I

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	T	P	
1	MA6003	Advanced Mathematics-I	3	1	0	4
2	EC6101	Advanced Digital Communication Techniques	3	1	0	4
3	EC6103	Information Theory & Coding Techniques	3	1	0	4
4	EC6105	Advanced Wireless & Mobile Communication Systems	3	1	0	4
5	EC6305	Antenna Theory and Techniques	3	1	0	4
Total Theory						**20**
Practical						
1	EC6191	Telecommunication System Engg. Lab	0	0	3	2
Sessional						
1	EC6181	Seminar	0	0	2	1
Total Practical & Sessional						**3**
Semester Total						**23**

SEMESTER – II

Theory						
Sl. No	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	T	P	
1	EC6102	Telecommunication Switching, Networks & Protocol	3	0	0	3
2	EC6104	Optical Communication Systems	3	1	0	4
3	EC6106	Advanced Digital Signal Processing	3	1	0	4
4		Elective – I	3	0	0	3
5		Elective – II	3	0	0	3
Total Theory						**17**
Practical						
1	EC6192	Advanced Design Simulation Lab	0	0	3	2
Sessional						
1	EC6182	Seminar	0	0	2	1
2	EC6184	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**5**
Semester Total						**22**

SEMESTER – III

Sl. No	Subject Code	Subject Name	Credit
1	EC6187	**Thesis Part-I**	**15**

SEMESTER – IV

Sl. No	Subject Code	Subject Name	Credit
1	EC6188	**Thesis Part-II**	**20**

DEPARTMENT ELECTIVES

ELECTIVE – I

Sl. No	Subject Code	Subject Name	Credit
1.	EC6108	Digital Image Processing	3
2.	EC6112	Communication and Network Security	3
3.	EC6313	Optimization Techniques in Engineering	3
4	EC6114	Spread Spectrum Techniques and Multiple Access	3

ELECTIVE – II

Sl. No	Subject Code	Subject Name	Credit
1.	EC6122	Satellite Communication Systems	3
2.	EC6124	Digital Voice and Video Communication	3
3.	EC6126	Microwave Communication Systems	3
4.	EC6128	Wireless Sensor Network	3
5.	EC6132	Mobility Management	3

SCHOOL OF ELECTRONICS ENGINEERING
SPECIALIZATION: VLSI DESIGN & EMBEDDED SYSTEM

SEMESTER-I

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	EC6201	Digital VLSI Circuits	3	1	0	4
2	EC6203	MOS Device Modelling	3	1	0	4
3	EC6205	Digital System Design	3	1	0	4
4	EC6207	Analog CMOS VLSI Circuits	3	1	0	4
5		Elective - I	3	0	0	3
Total Theory						**19**
Practical						
1	EC6291	VLSI Design Lab-1	0	0	3	2
2	EC6293	Digital System Design Lab	0	0	3	2
Sessional						
1	EC6281	Seminar-1	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**24**

SEMESTER-II

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1	EC6202	Embedded System Design	3	1	0	4
2	EC6204	Testing of VLSI Circuits	3	1	0	4
3		Elective – II	3	0	0	3
4		Elective – III	3	0	0	3
5		Elective – IV	3	0	0	3
Total Theory						**17**
Practical						
1	EC6292	VLSI Design Lab-II	0	0	3	2
2	EC6294	Embedded System Lab	0	0	3	2
Sessional						
1	EC6282	Seminar-II	0	0	2	1
2	EC6284	Comprehensive Viva Voce	-	-	-	2
Total Practical Sessional						**7**
Semester Total						**24**

SEMESTER-III

Sl. No	Subject Code	Subject Name	Credit
1.	EC6287	**Thesis Part-I**	**15**

SEMESTER-IV

Sl. No	Subject Code	Subject Name	Credit
1.	EC6288	**Thesis Part-II**	**20**

DEPARTMENT ELECTIVES

ELECTIVE-I

Sl. No	Subject Code	Subject Name	Credit
1.	EC6211	VLSI Technology	3
2.	EC6213	Architectural Design of IC	3
3.	EC6215	Microcontroller Based Design	3
4	CS6103	Advanced Computer Architecture	3

ELECTIVE-II, III & IV

Sl. No	Subject Code	Subject Name	Credit
1.	EC6222	Mixed Signal IC Design	3
2.	EC6224	Low Power VLSI Design	3
3.	EC6226	Advanced Digital VLSI Design	3
4.	EC6228	Optimization Techniques and Soft Computing Applications	3
5.	EC6232	Real Time Embedded Systems	3
6.	EC6234	RF IC Design	3
7.	EC6236	MEMS Design	3
8.	EC6238	Digital Signal Processor Architectures	3
9.	EC6242	CAD for VLSI	3
10.	EC6246	Memory Design	3

SCHOOL OF ELECTRONICS ENGINEERING
SPECIALIZATION: RF & MICROWAVE ENGINEERING

SEMESTER-I

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1.	MA6003	Advanced Mathematics-I	3	1	0	4
2.	EC6301	Advanced Electromagnetics	3	1	0	4
3.	EC6303	Microwave Devices and Circuits	3	1	0	4
4.	EC6305	Antenna Theory and Techniques	3	1	0	4
5.		Elective-I	3	0	0	3
Total Theory						**19**
Practical						
1.	EC6391	Advanced Microwave Engineering Laboratory	0	0	3	2
Sessional						
1.	EC6381	Seminar	0	0	2	1
Total Practical & Sessional						**3**
Semester Total						**22**

SEMESTER-II

Theory						
Sl. No.	**Subject Code**	**Subject Name**	**Contact Hours per Week**			**Credit**
			L	**T**	**P**	
1.	EC6302	RF Circuit Design	3	1	0	4
2.	EC6304	Computational Techniques in Electromagnetics	3	1	0	4
3.	EC6104	Optical Communication Systems	3	1	0	4
4.		Elective-II	3	0	0	3
5.		Elective-III	3	0	0	3
Total Theory						**18**
Practical						
1.	EC6392	Microwave Design and Simulation Laboratory	0	0	3	2
Sessional						
1.	EC6382	Seminar	0	0	2	1
2.	EC6384	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**5**
Semester Total						**23**

SEMESTER-III

Sl. No.	Subject Code	Subject Name	Credit
1.	EC6387	**Thesis Part-I**	**15**

SEMESTER-IV

Sl. No.	Subject Code	Subject Name	Credit
1.	EC6388	**Thesis Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

Elective-I

Sl. No	Subject Code	Subject Name	Credit
1.	EC6128	Wireless Sensor Network	3
2.	EC6311	Microwave Remote Sensing	3
3.	EC6313	Optimization Techniques in Engineering	3
4.	EC6113	Artificial Neural Network and Fuzzy Systems	3
5.	EC6115	Probability and Stochastic Processes	3

Elective-II

1.	EC6312	Electromagnetic Interference and Electromagnetic Compatibility	3
2.	EC6314	RADAR and Navigation Engineering	3
3.	EC6316	Microwave Integrated Circuits	3
4.	EC6102	Telecommunication Switching, Networks and Protocol	3
5.	EC6318	RF Micro-Electromechanical Systems	3

Elective-III

1.	EC6322	Planar and Small Antennas	3
2.	EC6122	Satellite Communication Systems	3
3.	EC6324	Adaptive Antennas and Smart Antennas	3
4.	EC6326	Millimeter Wave Communication Systems	3
5.	EC6114	Spread Spectrum Techniques and Multiple Access	3

SCHOOL OF MECHANICAL ENGINEERING
SPECIALIZATION: MANUFACTURING PROCESSES AND SYSTEMS

SEMESTER-I

Theory						
Sl No.	**Subject Code**	**Subject Name**	**Contact Hour per week**			**Credit**
			L	**T**	**P**	
1	ME6101	Project planning and control	3	1	0	4
2	ME6103	Metal Forming and Metal Casting	3	1	0	4
3	ME6105	Metal Cutting Technology	3	1	0	4
4	ME6107	Advanced Manufacturing and Fabrication Processes	3	1	0	4
5	ME6109	Robotics and robot applications	3	1	0	4
Total Theory						**20**
Practical						
1	ME6191	Manufacturing Processes and Precision Engineering Lab	0	0	3	2
2	ME6193	CIM Lab-I	0	0	3	2
Sessional						
1	ME6181	Seminar-I	0	0	2	1
					Total Practical & Sessional	**5**
Semester Toal						**25**

SEMESTER-II

Theory						
Sl.No.	**Subject Code**	**Subject Name**	**Contact Hour per week**			**Credit**
			L	**T**	**P**	
1	ME6102	CNC and Adaptive Control	3	1	0	4
2	ME6104	Metrology and Quality Control	3	1	0	4
3	ME6106	Optimization Techniques	3	1	0	4
4		Elective I	3	0	0	3
5		Elective II	3	0	0	3
Total Theory						**18**
Practical						
1	ME6192	Modelling and Simulation Lab	0	0	3	2
2	ME6194	CIM Lab-II	0	0	3	2
Sessional						
1	ME6182	Seminar-II	0	0	2	1
2	ME6184	Comprehensive Viva Voce	-	-	-	2
Total Practical & Sessional						**7**
Semester Total						**25**

SEMESTER-III

Subject Code	Subject Name	Credit
ME6187	**Thesis-Part I**	**15**

SEMESTER-IV

Subject Code	Subject Name	Credit
ME6188	**Thesis-Part II**	**20**

LIST OF DEPARTMENT ELECTIVES

ELECTIVE - I & II

Sl.No.	Subject Code	Subject Name	Credit
1.	ME6122	Finite Element Analysis	3
2.	ME6124	Rapid Response Manufacturing	3
3.	ME6126	Flexible Manufacturing Systems	3
4.	ME6128	Artificial Intelligence in Manufacturing	3
5.	ME6132	Intelligent Manufacturing and Condition Monitoring	3
6.	ME6134	Production System Design & Control	3
7.	ME6136	Competitive Manufacturing Strategies	3
8.	ME6138	Total Predictive Maintenance	3
9.	ME6142	Quality Engineering and Management	3
10.	ME6144	Advanced Materials and Processing	3
11.	ME6146	Design for Manufacturability and DFX	3
12.	ME6148	Work Science	3
13.	ME6152	Materials Management	3
14.	ME6154	Mechatronics	3
15.	ME6156	Automatic Control Systems	3
16.	ME6158	Environment-Benign Manufacturing	3
17.	ME6162	Designs of Experiment	3
18.	ME6164	Manufacturing Systems Engineering	3

SCHOOL OF MECHANICAL ENGINEERING
SPECIALIZATION: THERMAL ENGINEERING

SEMESTER-I

Theory						
Sl No.	**Subject Code**	**Subject Name**	**Contact Hour per week**			**Credit**
			L	**T**	**P**	
1	ME6201	Advanced Fluid Mechanics	3	1	0	4
2	ME6203	Advanced Thermodynamics	3	1	0	4
3	ME6205	Advanced Heat and Mass Transfer	3	1	0	4
4	ME6207	Finite Element Analysis of Heat and Fluid Flow	3	1	0	4
5		Elective-I	3	0	0	3
Total Theory						**19**
Practical						
1	ME6291	Thermal Engineering Lab.-I	0	0	3	2
2	ME6293	Engineering Software Lab.-I	0	0	3	2
Sessional						
1	ME6281	Seminar-I	0	0	2	1
Total Practical & Sessional						**5**
Semsester Total						**24**

SEMESTER-II

Theory						
Sl No.	**Subject Code**	**Subject Name**	**Contact Hour per week**			**Credit**
			L	**T**	**P**	
1	ME6202	Advanced Refrigeration & Air-Conditioning	3	1	0	4
2	ME6204	Thermal Systems Design & Optimization	3	1	0	4
3	ME6206	Computational Heat and Fluid Flow	3	1	0	4
4	ME6208	Theory of Combustion and Emission	3	1	0	4
5		Elective-II	3	0	0	3
Total Theory						**19**
Practical						
1	ME6292	Thermal Engineering Lab.-II	0	0	3	2
2	ME6294	Engineering Software Lab.-II	0	0	3	2
Sessional						
1	ME6282	Seminar-II	0	0	2	1
2	ME6284	Comprehensive Viva	-	-	-	2
Total Practical & Sessional						**7**
Semester Total						**26**

SEMESTER-III

Subject Code	Subject Name	Credit
ME6287	**Thesis-Part-1**	**15**

SEMESTER-IV

Subject Code	Subject Name	Credit
ME6288	**Thesis-Part-II**	**20**

LIST OF DEPARTMENT ELECTIVES

Elective-I

Sl. No.	Subject Code	Subject Name	Credit
1	ME6221	Gas Turbines and Jet Propulsion	3
2	ME6223	Alternative Fuels for IC Engines	3
3	ME6225	Analytical Methods in Heat Transfer	3
4	ME6227	Heat Exchanger Analysis and Design	3
5	ME6229	Introduction to Nano-Technology	3
6	ME6231	Experimental Methods in Thermal Engineering	3
7	ME6235	Environmental Pollution and Control	3
8	ME6237	Advanced Power Plant Engineering	3

Elective-II

1	ME6222	Advanced Turbo machinery	3
2	ME6224	Micro Scale Heat Transfer	3
3	ME6226	Bio Heat Transfer	3
4	ME6228	Energy Conservation and Management	3
5	ME6232	Non-Conventional Energy Sources	3
6	ME6234	Advanced Thermal Control Systems	3
7	ME6236	Cryogenic Engineering	3
8	ME6238	Artificial Intelligence	3

SCHOOL OF MECHANICAL ENGINEERING
SPECIALIZATION: MACHINE DESIGN

SEMSTER-I

Theory						
Sl No.	**Subject Code**	**Subject Name**	**Contact Hour per week**			**Credit**
			L	**T**	**P**	
1	ME6301	Theory of Elasticity and Plasticity	3	1	0	4
2	ME6303	Advanced Mechanics of Solids and Structures	3	1	0	4
3	ME6305	Noise and Vibration control Engineering	3	1	0	4
4		Elective - I	3	0	0	3
5		Elective - II	3	0	0	3
Total Theory						**18**
Practical						
1	ME6391	Numerical Simulation Lab	0	0	3	2
2	ME6393	Advanced Mech. Design Lab - I	0	0	3	2
Sessional						
1	ME6381	Seminar - I	0	0	2	1
Total Practical & Sessional						**5**
Semester Total						**23**

SEMSTER-II

Theory						
Sl No.	**Subject Code**	**Subject Name**	**Contact Hour per week**			**Credit**
			L	**T**	**P**	
1	ME6302	Engineering Tribology	3	1	0	4
2	ME6304	Finite Element Method	3	1	0	4
3	ME6306	Analysis and Performance of Composite Materials	3	1	0	4
4		Elective - III	3	0	0	3
5		Elective - IV	3	0	0	3
Total Theory						**18**
Practical						
1	ME6392	Advanced Mech. Design Lab - II	0	0	0	2
Sessional						
1	ME6380	Mechanical System Design Project	0	0	2	2
2	ME6382	Seminar – II	0	0	2	1
3	ME6384	Comprehensive Viva Voce	0	0	0	2
Total Practical & Sessional						**7**
Semester Total						**25**

SEMSTER-III

Sl No	Subject code	Subject Name	Credits
1	ME6387	**Thesis Part - I**	**15**

SEMSTER-IV

Sl No	Subject code	Subject Name	Credits
1	ME6388	**Thesis Part - II**	**20**

LIST OF DEPARTMENT ELECTIVES

Elective – I

Sl No	Subject Code	Subject Name	Credit
1	ME6321	Fracture and Fatigue based Design	3
2	ME6323	Experimental Stress Analysis	3
3	ME6325	Theory of Plates and Shells	3

Elective – II

1	ME6327	Simulation of dynamic Systems	3
2	ME6329	Theory of Advanced Mechanisms and Machines	3
3	ME6331	Advanced Control Theory	3

Elective – III

1	ME6322	Analysis of Functionally Graded Materials	3
2	ME6324	MEMS and NEMS	3
3	ME6326	Design Optimization	3

Elective – IV

1	ME6328	Dynamics of Rotors	3
2	ME6332	Theory of Non-linear Vibration and Shock	3
3	ME6334	Soft Computing and Optimization Techniques	3

SCHOOL OF CIVIL ENGINEERING

SPECIALISATION: CONSTRUCTION ENGINEERING AND MANAGEMENT

CE6101 PROJECT PLANNING AND CONTROL Cr-4

Project Preparation: Project Identification, Objectives, Project Planning Techniques: work breakdown structure, Bar Charts, LOB, CPM, PERT, use of soft-ware, PRIMAVERA. Problems. **14 Hrs.**

CPM: Network Elements, Errors, Fulkerson's Rule, Forward and Backward Pass Computation, Floats, Problems. **4 Hrs.**

PERT: Time Estimates, Beta and Normal distribution, Probability factor, Slack **4 Hrs.**

Man-material-machinery-money optimization: Cost functions, time –cost trade off, Cost Slope, Crashing, Problems. **8 Hrs.**

Resource planning, allocation and leveling/smoothening, Resources-based networks, Problems. **8 Hrs.**

Construction Material management: Objectives, purchases management and inventory control systems, ABC analysis, EOQ model, Problems. **6 Hrs**

Human Resource management. **4 Hrs.**

Text Books:

1. Construction Project management Theory and Practice by Kumar Neeraj Jha, Pearson- 2011
2. Construction, Planning and Management by U. K. Shrivastava, Galgotia Publication,N.D. New Edition-2012

Reference Books:

1. Project Management by K. Nagarajan, New Age International Publishers, Sixth Edition 2011.
2. Construction, Planning and Management. by Sengupta & Guha Tata Mc Graw Hill, ND 1995
3. Construction Project Management Planning, Scheduling and Control by Chitkara K.K (Tata Mc Graw Hill Publishing Co New Delhi ,1998)
4. Project Management with CPM, PERT and Precedence Diagramming by Moder. J. (Van Norstrant Reinhold Co)
5. Construction, Planning, Equipments and Methods. by R.L. Peurifoy (McGraw Hill) -2010
6. Construction, Planning and Management by Gahlot & Dhir, New Age Publisher- 2010
7. Construction scheduling with PRIMEVERA Project Planner by Feigenbaum, L. Prentice Hall Inc 1999
8. Principle of Construction Management by Pilcher Mc Graw Hill 1981

CE6103 CONSTRUCTION FINANCE MANAGEMENT Cr- 3

Construction accounting, Profit & Loss, Balance sheet, Income statement, Ratio analysis, Depreciation and amortization, Engineering economics, time value of money, discounted cash flow, NPV, ROR, PI, comparison, incremental rate of return, benefit-cost analysis, replacement analysis, break even analysis, risks and un-certainties. **12 Hrs.**

Management decision in capital budgeting, taxation and inflation. **6 Hrs.**

Work pricing, cost elements of contract bidding and award, revision due to unforeseen causes, escalation. **4 Hrs.**

Turnkey activities, project appraisal and project yield, working capital management finance. International Finance, **4 Hrs.**

Budgeting and budgetary control, Performance budgeting appraisal through financial statements. **4 Hrs.**

Practical problems and case studies, project cash flow. **4 Hrs.**

Text Books:

1. Engineering Economics by R.Pannerselvam P.H.I , N.D. 2012
2. Construction Planning & Management U.K.Shrivastava, Galgotia N.D, 2012

Reference Books:

1. Project Planning, Analysis, Selection, Implementation & Review. by Prasanna Chandra (Tata McGraw Hill Publishing Co Ltd,ND)-2010
2. Essentials of Management. by Harold Koontz and Heinz Weihrich (Mc Graw Hill)
3. Principles of Management. by Dr. M. .M. Verma and Agarwal, Himalaya Publisher, 2008
4. Essentials of Management. by B.P. Singh and J.N Chhabra, South Western College Publishing-1991
5. Industrial Engg and Management by Dr.O.P.Khanna, Khanna Publisher - 2008
6. Engineering Economics by J.L.Reggs., Mc Graw Hill , 1976
7. Construction Management and Planning by B.Sengupta and H.Guha Tata Mc Graw Hill, ND 1995
8. Principle of Construction Management by Pilcher, Mc Graw Hill, 1981

CE6109 BUILDING SCIENCE Cr-4

Climatic factors, classification of tropical climates, site climate, microclimate of human settlements, 8Hrs

Ventilation requirements for health, mechanisms and estimation for natural ventilation, airflow patterns in building. 8Hrs

Thermal comfort factors, comfort indices, thermal quantities, heat exchange in buildings, periodic heat flow, mechanical and structural means of thermal control, Moisture control in buildings, 8Hrs

Propagation of sound, sound insulation, absorption and transmission, reverberation, design of floor, roofing and walling system for sound absorption and insulation, design of auditoria, noise control in buildings, 12Hrs

Day lighting, design of fenestration in buildings for day light of various types, illumination design, luminaries and their characteristics, codal requirements. 12Hrs
Introduction to functional based design for example hospital structures, residential structures, hotels, factories, IT buildings etc.

Text Books:

1. Manual of Tropical Housing and Buildings (Climatic Design) by O.H.Koenigsberger, T.G.Ingersoll, Alan Mayhew & S.V.Szokolay (Orientloagman) ,160 Anna Salai,Madras-2
2. Building Construction by Verghese PHI EEE New Delhi- 2012

Reference Books:

1. Building Environment by D.Ailtasimha (TMH), 12/4 Asafali Road, N.D.11002
2. Environmental Control System. by Mooref (McGraw-Hill Inc,1994)
3. Basic Environmental Technology (Water Supply waste Management, & Pollution Management Nathanson PHI India, 2010

CE6105 MATERIAL TECHNOLOGY Cr-3

Cement and Concrete: **10 Hrs**
Portland cement: chemical composition, hydration of cement, structure of hydrated cement, mechanical strength of cement gel, water held in hydrated cement paste and heat of hydration. Cements of different types. Factors affecting the strength of concrete. Elasticity, shrinkage and creep of concrete
Durability of concrete: Permeability of concrete, Chemical attack of concrete, air-entrained concrete and thermal properties of concrete. The mechanical test of hardened concrete .Light weight and high density concrete. Mix design. Statistical quality control; Biaxial strength of concrete, Fibre reinforced concrete. **12 Hrs**
Metals: Behaviour of common constructional metals in tension and compression. True stress-strain curve for mild steel in simple tension. Theories of failure and yield surfaces. **6 Hrs**
Fatigue properties: Nature of fatigue failure, fatigue strength for completely reversed stresses, fatigue strength with super imposed static stress and factors influencing fatigue strength. **4 Hrs**

Temperature and Creep properties: Low temperature properties, high temperature properties, creep-stress-time-temperature relations for simple tension, mechanics of creep in tension. Structure of materials and their imperfections. Deformation of crystals and theory of dislocations.

4 Hrs

Text Books:

1. Concrete Technology, M.L. Gambhir, TaTa Mc Graw-Hill, New Delhi, 2012
2. Concrete Technology- M S Shetty, S.Chand Publisher, 2013

Reference Books:

1. Properties of Concrete- A M Neville-Pearson Education.-2008
2. Mechanical Behavior of Engineering Materials- A J Martin
3. Theory of Flow and Fracture of Solids, A. Nadai, Mc Graw-Hill, NY.
4. Strength of Materials- Part II; by S P Timoshenko,

CE6107 QUANTITATIVE METHODS IN CONSTRUCTION MANAGEMENT Cr-4

Introduction, concept of probability and statistics,	**10Hrs**
Liner programming,	**6Hrs**
Transportation and Assignment problems,	**8Hrs**
Dynamic Programming,	**4Hrs**
Queuing theory, Decision theory, Games theory,	**10Hrs**
Simulations applied to construction,	**4Hrs**
Modifications and improvement on CPM/PERT techniques	**6Hrs**

Text Books:

1. Operations Research: An Introduction," by Taha,H.A (Prentice-Hall of India)- 2010

Reference Books:

1. Operations Research by B.S .Goel. and S.K. Mittal, Pragati Prakashan, Meerut,2000.
2. Fundamentals of Mathematical statistics. by S.C. Gupta and V.K Kapur (Sultan Chand & Sons, New Delhi,1999)
3. Theory of Probability. by Scum Series.2010
4. Computer Applications in Construction by Paulson, B.R. Mc Graw Hill-1995

CE6102 CONSTRUCTION ENGINEERING PRACTICES Cr-4

Concrete construction methods;	**4Hrs**
Form work design and scaffolding, slip form and other moving forms,	**8Hrs**
Pumping of concrete and grouting, mass concreting (roller compacted concrete), ready mixed concrete. Various methods of placing and handling concrete,	**6Hrs**
Accelerated curing, hot and cold weather concreting, under water concreting,	**4Hrs**
Pre-stressing, Steel and composites construction methods;	**4Hrs**
Fabrication and erection of structures including heavy structures,	**4Hrs**
Prefab construction, Industrialized construction,	**4Hrs**
Modular coordination, Special construction methods,	**6Hrs**
Construction in Marine environments, high rise construction, Bridge construction including segmental construction, incremental construction and push launching techniques, River valley projects	**8Hrs**

Text Books:

1. Formwork for Concrete Structures by Robert L Peurifoy and Garold D.Oberiender McGraw-Hill,1996

Reference Books:

1. Formwork for Concrete Special Publication No-4,(Fifth Edition) by.M.K Hurd. (American Concrete Institute, Detroit1980)
2. Guide for Concrete Formwork. American Concrete Institute. Box No 19150, Detroit, Michigan-48219.

CE6104 ADVANCED CONSTRUCTION MATERIALS Cr-4

Light weight material,	**2Hrs**
Fibers in reinforced concrete, types of fibres, workability, mechanical and physical properties of fibre reinforced concrete,	**4Hrs**
Industrial waste materials in concrete: their influences on physical and mechanical properties, and durability of concrete,	**2Hrs**
Concrete at high temperature, high strength concrete, Change in concrete with time,	**6Hrs**
Corrosion of concrete in various environments, Corrosion of reinforcing steel, electrochemical process, measures of protection, Ferro-cement material and properties,	**12hrs**
Polymers in Civil Engineering, Polymers, fibers and composites, Fiber reinforced plastic in sandwich panels, modeling, Architectural use and aesthetics of composites,	**10Hrs**
Adhesives and sealants, Structural electrometric bearings and resilient seating, Moisture barriers,	**4Hrs**
Polymer foams and polymer resin Building Physics, Polymer concrete composites	**8Hrs**

Text Books:

1. Civil Engineering Materialsby Shansomayoji Second Edition, Prentice Hall Inc-2001
2. Building Materials by Verghese PHI EEE New Delhi-2012

References Books:

1. Materials for Civil and Highway Engineers by Derucher, K.Korfiatis-G and Ezeldins, Fourth Edition, Prentice Hall Inc,1999
2. High performance Concrete by Aitkens. , Mc Graw hill,1999

CE6106 CONSTRUCTION METHODS AND EQUIPMENTS Cr-4

Construction Equipments: Factors affecting selection of equipment, Owning and Operating Cost.	**6Hrs**
Construction Equipment fundamentals: Classification of Construction Equipment, Earth moving Equipments, Hauling, Hoisting, Conveying Equipments, Aggregate and concrete production Equipments, Pile Driven Equipments, Cranes.	**24Hrs**
Analysis of production output and costs of Excavating Equipments, Characteristics and performances of equipment for Earth moving.	**18Hrs**
Deep excavation support systems: Diaphragm wall, sheet piling, secant pile, contiguous pile, strutting, ground anchors	

Text Books:

1. Construction Planning, Equipment and Methods. R.L.Peurifoy,P.E Clofford ,J Sehexnayder, P.E., Tata Mc Graw Hill Publishing ,N.D-2012
2. Construction Engineering and Management by S. Seetharaman, 4th Edition-2007, Laxmi Publication-2008

Reference Books:

1. Construction Equipment and Job Planning by S.V.Deodhar, Khanna Publisher -2008
2. Construction Equipment and Management by S.C.Sharma (Khanna Publishers, New Delhi)-2008
3. Construction Equipment and its Planning and Application by Dr.Mahesh Verma (Metro Politan Book Company, New Delhi)
4. Construction Planning and Equipment by Satyanarayana and Saxena, Standard Publishers- 2008
5. Heavy Construction by Vazirani and Chandola, Khanna Publisher Delhi -2008

CE6182 SEMINAR Cr-1

The topics of the seminar preferably to be related to the subjects. **24Hrs**

CE6192 MATERIAL TESTING LAB.-II Cr-2

NDT Test: Rebound Hammer Test, Ultrasonic Pulse velocity Test, Pull out Test. **36Hrs**

CE6132 SYSTEMS DESIGN AND VALUE ANALYSIS Cr-3

Analysis synthesis, appraisal, system, design procedure, objectives and constraints, application to buildings, **12Hrs**

Value analysis, Introduction, function analysis, job plan, Value savings during Analysis synthesis, Appraisal, **12Hrs**

System design procedure, objectives and constraints, construction, Value management, Case studies in Value engineering **12Hrs**

Text Books:

1. Techniques of Value Analysis and Engineering L.D.Miles, Mc Graw Hill co 1970.
2. Construction Engineering and Management by S. Seetharaman, 4th Edition-2007, Laxmi Publication

Reference Books:

1. Value Engineering Analysis and Methodology by Del L Younker, Published by AI Books .co.in CRC Press.

CE6134 PROJECT QUALITY AND SAFETY MANAGEMENT Cr-3

Introduction to quality planning and control of quality during design of structures, Quantitative techniques in quality control, Quality assurance during construction, Inspection of materials and machinery in process inspection and test, Preparation of quality manuals, check list and inspection report, Establishing quality assurance system, Quality standards/ codes in design and construction, **14Hrs**

Concept and philosophy of total quality management (TQM), Training in quality and quality management systems (ISO-9000), **6Hrs**

Concept of safety, Factors affecting safety, Physiological, Psychological and Technological, Planning for safety provisions, Structural safety, Safety consideration during construction, demolition and during use of equipment, Management of accidents/ injuries and provision of first aid, Provisional aspect of safety, Site management with regard to safety recommendations, Training for safety awareness and implementation, Formulation of safety manuals, safety legislation, standards/ codes with regard to construction, Quality vs Safety. Case studies **16Hrs**

Text Books:

1. Construction Safety by Jimmy W.Hinze, Prentice Hall Inc 1997
2. Tamilnadu Factory Act Construction Planning and Management by UK Shrivastav, Golgotia Publication – 2000

Reference Books:

1. Construction Safety and Health Management by Richard j.coffe, jimmie Hinze and Theo C.Haud Prentiee Hall Inc-2001

CE6136 BUILDING SERVICES PLANNING Cr-3

Components of urban forms and their planning, **4Hrs**

Concepts of neighborhood unit, Street system and layout in a neighborhood, **4Hrs**

Functional planning of buildings, optimization of space; Spatial Synthesis graphical techniques, heuristic procedures, formulation of linear and non-linear optimization problem. **12Hrs**
Space requirements and relationships for typical buildings, like residential offices, hospitals
Standard fire, fire resistance, classification of buildings, means of escape, alarms,

Engineering services in a building as a systems, Lifts, escalators, cold and hot water systems, waster water systems, and electrical systems. **16Hrs**

Text Books:

1. Environmental Control Systems by Mooref, McGraw Hill,Inc 1994
2. Building Services by Peter R.Smith and Warren G.Jullian, Applied Science Publisher ltd, London

Reference Books:

1. Hand book of Buildings and Enclosure by A.J.Elder and Martix Vinder Bary, McGraw Hill Book Co, 1982
2. The fire Precautions Act in Practices 1987, Janetaylor and Gordin Coone.

CE6138 ADVANCED REPAIRS AND REHABILITATION OF STRUCTURES Cr-3

1. **Introduction:** Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors. **4Hrs**

2. **Structural Strengthening:** Strengthening and retrofitting of columns, beams, walls, footings and slabs, piers of concrete structures by jacketing, external post-tensioning, replacing or adding reinforcement, plate bonding, textile reinforced concrete. **6Hrs**

3. **Specialized Repairs:** Electro chemical repair using re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc, Repair of damaged structures of water retaining structures, hydraulic structures, Pavements and Runways, Tunnels, Bridges, Piers and Flyovers, Parking Garages, Underwater repair, Masonary Repair, Repair and Restoration of Heritage Structures. **8Hrs**

4. **Retrofitting by composite materials:** Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass). **6Hrs**

5. **Seismic Retrofitting:** Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures. **6Hrs**

6. **Post-Repair Maintenance of Structures:** Protection & Maintenance schedule against environmental distress to all those structures. **6Hrs**

7. Special cares in repair and rehabilitation of heritage structures.

Text Books:

1. Repair of Concrete Structures by R. T.Allen and S. C.Edwards, Blakie and Sons, UK,1987.
2. M. S. Shetty, Concrete Technology - Theory and Practice, S. Chand and Company, ND- 2013

Reference Books:

1. Concrete Structures by Denison Campbell, Allen and Harold Roper, Materials, Maintenance and Repair, Longman Scientific and Technical UK, 1991.

CE6142 CONTRACT LAWS AND REGULATIONS Cr-3

Project cost estimation, rate analysis, overhead charges, **4Hrs**

Bidding models and bidding strategies, Qualification of bidders, Owner's and contractor's estimate, **4Hrs**

Tendering and contractual procedures, **4Hrs**

Indian Contract Act 1872, Definition of Contract and its applicability, Types of contracts, International contracts, FIDIC, Conditions and specifications of contract, Contract administration, **12Hrs**

Claims, compensation and disputes, Dispute resolution techniques, Arbitration and Conciliation Act 1996. Arbitration case studies, Professional ethics, Duties and responsibilities of parties Management Information system. **12Hrs**

Text Books:

1. Estimating, Costing and Valuation by Sc.Rangwala , K.S.Rangwala & K.K.Rangwala-2010
2. Estimating and costing by B.N.Dutta, S.Chand-2012

Reference Books:

1. Construction Equipment and Job Planning by S.V.Deodhar, Khanna Publishers Naisarak, Delhi
2. Laws Relating to Building and Engineering Construction in India by Gajaria G.T (M. M. Tripathi Private Ltd, Bombay,1982)
3. Contracts and the legal Environment for Engineers and Architects by Joseph T.Bockrath (6th Edition Mc Graw hill 2000)
4. Estimating, Costing, Specification and valuation by M.Chakraborti, Standard Publisher-2010
5. Text Book of Estimating and costing by GS Birde. "Construction , Planning and Management by P.S.Gahlot, B.M. Dhir, New Age International Publisher. 2010.

CE6144 FOUNDATION ENGINEERING Cr-3

Foundation Construction Methods **6Hrs**
Construction of shallow foundations and deep foundations

Foundations on Problematic Soils **10Hrs**

Weak and compressible soil, expansive soil, collapsible soil, Frozen Soil, Corrosion Soils Ground Improvement Techniques **10Hrs**

Removal and Replacement, Pre compression, In-Situ densification, In-Situ replacement, Grouting, Deep soil mixing, Stabilization using Admixtures, Reinforcement
Geo Environmental Engineering **10Hrs**
Types of underground contamination, Sources of underground contamination, Fate and transport of underground contaminants, Geo-environmental site characterization, Remediation methods, sanitary landfills

Text Books:

1. Geotechnical Engineering by Shashi K.Gulhati & Manoj Datta (Tata Mc Graw Hill Publishing company Ltd New Delhi-2010)
2. Foundation Engineering by P.C Varghees, PHI Publication-2010

Reference Books:

1. Ground Improvement Technique by Dr.D.Purushothama Raj, Laxmi Publication, New Delhi
2. Soil Mechanics & Foundation Engineering by P.Purushothama Raj (Pearson Education Publication 2010)
3. Geotechnical Engineering, Principles and Practice by Donald P. Coduto, Pearson Education publisher-2010

CE6146 QUALITY CONTROL IN CONSTRUCTION Cr-3

Construction Organization **10Hrs**

Types of Organization-Inspection, Control and enforcement, Quality Management Systems and Method, Responsibilities and authorities in Quality assurance and Quality control-Architects, Engineers, Contractors, and Consultants, Quality circle

Quality Planning **10Hrs**

Quality policy, Objectives and methods in construction industry-Consumer satisfaction- Ergonomics - Time of Completion-Statistical Tolerance-Taguchi's concept of quality- Codes and standards-Documents-Contract and construction programming -Inspection procedures - Processes and products-Total QA / QC Program and cost implication.

Quality Assurance and Control **16Hrs**

Objectives-Regularity agent- Owner, design, contract and construction oriented objectives, methods-Techniques and needs of QA/QC- Different aspects of quality- Appraisals, Factors influencing construction quality-Critical, major failure aspects and failure mode analysis,-Stability methods and tools, Optimum design-Reliability testing, reliability coefficient and reliability prediction-Selection of new materials-Influence of drawings, detailing, specification, Standardization-Bid preparation-Construction activity, Environmental safety, Social and environmental factors-Natural causes and speed of construction-Life cycle costing Value Engineering and value analysis.

Text Books:

1. Construction Inspection Handbook by Quality Assurance and Quality Control, by James, J.O Brian,Van Nostrand, New York, 1989.

Reference Books:

1. Fundamental of Construction Management and Organization, by Kwaku A., Tenah and Jose M.Guevera Prentice Hall of India, 1995.
2. Quality planning and Analysis, by Juran Frank, J.M. and Gryna, F.M. Tata McGraw Hill, 1982.
3. ISO 9000, Viva Books, by Hutchins. G., NewDelhi, 1993.
4. Productivity Improvement in Construction, by Clarkson H. Oglesby, McGraw Hill 1989.
5. The Management of Quality in Construction, by John L.Ashford, E & F.N Spon, New York, 1989.
6. Quality Improvement Techniques in Construction, by Steven McCabe, Addisson Wesley Longman Ltd., England, 1998.

SCHOOL OF CIVIL ENGINEERING

SPECIALISATION: STRUCTURAL ENGINEERING

CE6201 ADVANCED STRUCTURAL ANALYSIS Cr-4

Static and kinematic indeterminacies, Energy theorems. Influence coefficients, **12 Hrs.**

Flexibility and Stiffness Matrices for Pin jointed 2D and 3D structures, **12 Hrs.**

2D rigid jointed structures, plane grids. **12 Hrs.**

Direct stiffness method, Substitute technique. **12 Hrs.**

Text Books:

1. Matrix Analysis of Framed Structures, by William Weaver JR & JM Gere. CBS publication, Daryaganj, New Delhi, 1986
2. Structural Analysis (A Matrix Approach) by G.S. Pandit & Gupta, Tata McGraw Hill ND 2006

Reference Books:

1. Matrices for Structural Analysis by Sydney John McMinn, E & F.N.SPON ltd, London
2. Problems in Structural Analysis by Matrix Methods by P.Bhatt. A.H. Wheeler Company Pvt. Ltd. Allahabad, 1989
3. Matrix Finite Element Computer & Structural Analysis by M. Mukhopadhyay -Oxford & IBH Publishing Company, Park street, Kolkata, 1984

CE6203 THEORY OF ELASTICITY & PLASTICITY Cr-3

Plane stress and plane strain problems: **7 Hrs.**

General stress and strain equations (Equilibrium and compatibility equations). Two dimensional problems in rectangular coordinates. Stress and strain components, differential equation, equilibrium equations and compatibility

Equations in polar coordinate: **7 Hrs.**

Stress distribution for axisymmetric problems. Pure bending of curved bars, thick walled cylinder. Concentrated force at a point of straight boundary. Force acting on the end of a wedge. Concentrated force acting on a beam.

Effect of circular holes on stress distributions in plates: **7 Hrs.**

Stress and strain in three dimensions: Principles stresses, maximum shearing stress, principal axes of strain. Stretching of prismatic bar by its own axis, Elementary problems of elasticity in three dimensions.

Torsion of non–circular prismatic bars: **5 Hrs.**

Saint Venant's Theory. Various Analogies. Torsion of hollow and thin sections

Introduction to the theory of plasticity: **10 Hrs.**

The yield criteria of metals, stress space representation of yield criteria. Stress strain relations, plastic potential, flow rules and maximum work hypothesis. Two dimensional plastic flow problems. Incompressible two dimensional flow, stresses in plastic materials in condition of plane strain, equation of equilibrium, the simple slip-line fields.

Text Books:

1. Theory of Elasticity by S.P. Timoshenko and J.N. Goodier, Mc Graw- Hill
2. Theory of Plasticity by Hoffman and Sachs, McGraw-Hill, 1953

Reference Books:

1. Plasticity of Mechanical Engineers by W. Johnson and P.B. Meller, North-Holland Publishing Company- 1973
2. Theory of Flow and Fracture of Solids by A. Nadai Mc Graw-Hill, NY- 1985.

CE6205 NUMERICAL METHODS IN CIVIL ENGINEERING Cr-4

Linear equations and eigenvalue problems. Accuracy of approximate calculations. Nonlinear equations,

interpolation. Differentiation and evaluation of single and multiple integrals. **12 Hrs.**

Initial and boundary value problems of finite difference method. **12 Hrs.**

Newton's method, variation and weighted residual methods. **12 Hrs.**

Introduction to finite element method. **12 Hrs.**

Text Books:

1. Numerical Methods in Civil Engineering by Krishna Raju, Macmillan Publishers India, 2000

Reference Books:

1. Computer Programming & Engineering Analysis by I.C. Syal & S.P.Gupta- Publishor-AH wheeler & co private ltd,1980
2. Numerical Methods in Civil engineering by Rajsekharan, Vikas Publishing House Pvt. Ltd., 2000

CE6105 MATERIAL TECHNOLOGY Cr-3

Cement and Concrete: **10 Hrs.**

Portland cement: chemical composition, hydration of cement, structure of hydrated cement, mechanical strength of cement gel, water held in hydrated cement paste and heat of hydration. Cements of different types. Factors affecting the strength of concrete. Elasticity, shrinkage and creep of concrete

Durability of concrete: Permeability of concrete, Chemical attack of concrete, air-entrained concrete and thermal properties of concrete. The mechanical test of hardened concrete .Light weight and high density concrete. Mix design. Statistical quality control; Biaxial strength of concrete, Fibre reinforced concrete. **10 Hrs.**

Metals: Behaviour of common constructional metals in tension and compression. True stress-strain curve for mild steel in simple tension. Theories of failure and yield surfaces. **7 Hrs.**

Fatigue properties: Nature of fatigue failure, fatigue strength for completely reversed stresses, fatigue strength with super imposed static stress and factors influencing fatigue strength. **4 Hrs.**

Temperature and Creep properties: Low temperature properties ,high temperature properties, creep-stress-time-temperature relations for simple tension, mechanics of creep in tension. Structure of materials and their imperfections. Deformation of crystals and theory of dislocations. **5 Hrs.**

Text Books:

1. Concrete Technology- M S Shetty, S. Chand Publisher -2013
2. Mechanical Behavior of Engineering Materials- A J Martin, Konark Publishers Pvt. Ltd

Reference Books:

1. Properties of Concrete- A M Neville-Pearson Education, 2008.
2. Concrete Technology, M.L. Gambhir, TaTa Mc Graw-Hill, New Delhi-2012
3. Theory of Flow and Fracture of Solids, A. Nadai, Mc Graw-Hill, NY.
4. Strength of Materials- Part II; by S P Timoshenko, PWS Publishing- 1997

CE6202 ADVANCED STEEL DESIGN Cr-4

1. Design of Gantry girder.
2. Design of cold formed light gauge steel beams and columns.
3. Design of roof truss.
4. Design of power transmission tower.
5. Design of water tank with staging.
6. Design of self supported steel chimney.

Text Books:

1. "Design of steel Structures (LSM)", by S.K Duggal Mc Graw Hill Education pvt Ltd.
2. "Design of Steel Structure", by N.Subramanian, S2nd edition, Oxford publication.

Reference Books:

1. "Design of Steel Structure" by K.S.Sai Ram, Pearson Education Pvt. Ltd, New Delhi.
2. "Design of Steel Structures V-II", by S. Ramchandra, Standard pub.
3. "Design of steel structure", by S.S Bhavikatti, I.K I Publishers.
4. "Design of steel structure", by Gaylord & Gaylord., TMH publication, 3 edition, 2010.

CE6204 ADVANCED REINFORCED CONCRETE DESIGN Cr-3

Limit state design philosophy, redistribution of moment in continuous span beams, plastic hinge concept, rotation capacity of sections and detailing for ductility, **12 Hrs.**

Yield line theory for slabs, equilibrium and virtual work methods, shrinkage and creep, analysis for stresses in compression and flexural members, deflections, shear wall and coupled shear wall, beam column joints**,** **16 Hrs.**

Prestressing of continuous beams and portal frames, partial prestressing, circular prestressing . **8 Hrs.**

Text Books:

1. Limit State Design of Reinforced Concrete by P.C. Varghese, PHI, New Delhi
2. Reinforced Concrete Design by S U Pillai and D-Menow, Tata Mc Graw Hill, NR 1998 Benner

Reference Books :

1. Hughes, B.P., "Limit state Theory for Reinforced Concrete, Pitman Publishing, Bath," U.K.,
2. Reinforced Concrete Designers Hand book by C.E. Renold and J.C. Steedman Publisher Rupa & Co. New Delhi 1981
3. Yield line theory by K.W.Johansen (Translated from Danish) Cement Concrete Association London 1962
4. Yield Line Analysis of Slabs by L.L. Jones and R.H. Wood , Thames and Hudson Chatto and Winders, London
5. Design of Prestressed Concrete Structures by T.Y. Lin and H. Burns, John Willy and sons NY
6. Prestressed Concrete Theory and Design by E.W Bennet, Chapman and Hall, London.
7. Prestressed Concrete by Krishnaraju, McGraw-Hill Education, 2008

CE6206 STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING. Cr-4

Single Degree System: **12Hrs**

Equation of motion, Free, forced, damped and undamped vibration.

Multidegree freedom system: **20 Hrs.**

Generalized single degree freedom, generation of mass, stiffness and damping matrices,

Ground motion, static and dynamic analysis, Codal provisions. **16 Hrs.**

Text Books:

1. Dynamics of Structure (Theory and application to earthquake Engineering) by A. K. Chopra, PHI- 2007
2. Earthquake Resistant Design of Structure by Agrawal and Shrikhande, PHI, New Delhi 2007.

Reference Books:

1. Theory of Vibration (with application) by W. T. Thomson, CBS Publication & Distributor Delhi- 1990
2. Vibration Problems in Engineering by Timoshenko and D.H. Young- D Van Nostrand and Co. New York.

CE6208 STABILITY OF STRUCTURES Cr-3

Torsion of thin walled open sections, warping displacements under pure torsion,-Warping constants for rolled steel section. Strain energy in bending and torsion of members of thin walled open section including the effects of warping. Torsional buckling including the effects of Wagner's effect, flexural torsional buckling (with centroid and shear centres coincident). **8 Hrs.**

Lateral buckling of beams under pure bending central point load through centre of gravity of the section. Cantilever beams with point load at the free end, Application of Rayleigh-Ritz method. **8 Hrs.**

Beam-columns on rigid supports-concentrated and continuous lateral loads with simply supported and built in-ends. Continuous beam with as axial loads. Application of trigonometric series. In-plane buckling of bars. **8 Hrs.**

Approximate calculation of critical loads for bar structures by energy method- a bar on elastic foundation, a bar with intermediate compressive forces, bar under distributed axial loads, a bar with changes in cross section. **4 Hrs.**

Effects of shearing force on the critical load. Buckling of built-up columns. In-elastic in-plane buckling of columns. Tangent and reduced modulus concept, Shanley's contribution, elastic critical loads for rigid frames and triangulated structures, stability functions. Bending of thin plate. Buckling of thin rectangular plates in compression, shear and bending. **8 Hrs.**

Text Books:

1. Theory of Elastic Stability by S.P.Timosheko & Gere, McGraw-Hill, 1961

Reference Books :

1. Structural Members and Frames by T.V Galambos Prentice-Hall INC, 1968.
2. The stability of Frames by M.R.Horns and W.Merchang Porgamon press, 1965.
3. Elastic Instability by M.Gregory, Spon's Civil Engineering series,1967.
4. Buckling Strength of Metal structures by F.Bleich, Mc Graw Hill Book co.,1952
5. Structural Stability (Theory and implementation) by W.F. Chen and EM Lui Elsevier NY

CE6231 FINITE ELEMENT METHODS Cr-3

Introduction: The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods. Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method. **12 Hrs.**

One and Two Dimensional Problems: Detail formulation including shape functions. stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria. Finite Element modeling of two dimensional problems using Constant strain Triangle(CST) elements, Stress strain relations for isotropic and orthotropic materials, Four nodded rectangular elements, axisymmetric solids subjected to axisymmetric loading. **16 Hrs.**

Isoparametric Elements: Natural coordinates, isoparametric elements, four node, eight node elements. Numerical integration, order of integration. **4 Hrs.**

Plate Bending: Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modeling. **4 Hrs.**

Text Books:

1. Concepts and Applications of Finite Element Analysis by R. D. Cook., John Wiley2002(4th)
2. Finite Element Analysis – Theory and Programming by C.S. Krishnamoorthy, Tata Mc Hill-1995

Reference Books :

1. Finite Element Method by O. C Zienkiewicz .and R. L. Taylor Mc Graw Hill- 1977
2. A First Course in the Finite Element Method by D. L Logan,., PWS Publishing, Boston-1997
3. Finite Element Analysis-Theory and Programming by C. S. Krishnamoorthy, Tata Mc Hill-1995.

CE6233 THEORY OF PLATE AND SHELLS Cr-3

Plates: Pure bending of plates, Slope and curvature of slightly bent plates, relationship between moment and curvature, strain energy in bending of plates. Differential equations for symmetrical bending of circular plates under lateral loads. Uniformly loaded, concentrically loaded and loaded at the center of simply supported and fixed circular plates. Differential equation of the deflection surface and boundary conditions of laterally loaded rectangular plates by classical theory. Solutions of simply supported rectangular plates due to sinusoidal loads, uniformly distributed loads and concentrated load by Navier's Solution, Levy approach. **16 Hrs.**

Shells: Membrane theory of symmetrical loaded shells of revolution, Spherical shells, conical shells, Membrane theory of cylindrical shells and shells of Double curvature such as Hyperbolic paraboloids and elliptic paraboloids, conoids. Circular cylindrical shells loaded symmetrically with respect to its axis, particular cases of symmetrical deformation of circular cylindrical shells, cylindrical tanks of uniform wall thickness. **14 Hrs.**

Structural Design: Design of spherical dome. **6 Hrs.**

Text Books :

1. Theory of Plates and Shells- by S P Timoshenko and S. W. Krieger, Mc Graw Hill, NY-1984

Reference Books :

1. Thin Shell Concrete Structures – by O P Billington, Mc Graw Hill, NY
2. Design and Construction of Concrete Shell Roofs by G.S.Ramaswam Mc Graw Hill, NY-1984
3. Stress in Shells by W. Flugge, Springer Verlag, NY- 1973

CE6235 ADVANCED FOUNDATION ENGINEERING Cr.-3

Machine Foundations: Types of Machine Foundations, Basic Definitions, Degree of Freedom of a Block Foundation, General criteria for design of Machine Foundations, Free Vibration, Forced Vibration, Vibration analysis of a Machine Foundation, Determination of Natural Frequency, Design Criteria for Foundations of Reciprocating machines, Reinforcement and construction Details, Mass of Foundation, Vibration Isolation and Control. **9 Hrs.**

Liquefaction of foundation soils under earthquakes: Introduction, Liquefaction Phenomenon, Effect of Liquefaction on Build environment, Factors Affecting Liquefaction, Assessment of Susceptibility of a Soil to Liquefaction, Prevention of Liquefaction. **9 Hrs.**

Foundations on Expansive soils: Expansive soils, Identification of Expansive soils, Classification of Expansive soils, Causes of moisture changes in soils, Effects of swelling on buildings, Preventive measures for expansive soils Modification of Expansive soils, Design of foundation in swelling soils, Drilled piers, Belled drilled pier, Under reamed piles, construction of under reamed piles. **9 Hrs.**

Foundation Soil Improvement: Stabilization of soil with granular skeleton, chemical, cement, lime , ash, slag & bitumen, Thermal stabilization, Electrical stabilization, Vibration methods of ground improvement, Drainage methods of ground improvement, Pre-compression and vertical drains, Grouting and injection, Reinforced earth, Use of geotextile & modern materials Ground anchors & soil nails. **9 Hrs.**

Text book:

1. "Advanced Foundation Engineering", by V. N. S, Murthy, First Edition, CBS Publishers & Distributors.
2. "Foundation Analysis and Design", by J.E.Bowls, 5th Edition, McGraw Hill Higher Education, 1997.

Reference Book

1. "Soil mechanics and foundation Engineering", by K.R.Arora.
2. Geotechnical engineering handbook by B.M.Das, J.Ross Publishing, Cengage learning.
3. "Principles of Foundation Eng." by B.M.Das, 7th Edition, Cengage Learning India Pvt. Ltd, New Delhi.
4. "Geotechnical Engineering Principles and Practices" by Donald P. Coduto, Man Chu
5. "Ronald Yeung & William A. Kitch", Prentice Hall, 2011.
6. "Soil Improvement techniques and their evolution", by Van Impe.
7. "Geotechnical Engineering", by Shashi K. Gulhati & Manoj Datta
8. "Foundation Engineering", by P.C.Verghese
9. "Ground Improvement techniques", by P.Purushothama Raj

CE6237 CONSTRUCTION PLANNING & MANAGEMENT Cr-3

Project Preparation: Project Identification, Objectives & project Planning Techniques: work breakdown structure, Bar Charts, LOB, CPM, PERT, use of soft-ware, PRIMAVERA. Problems. **10 Hrs.**

CPM: Network Elements, Errors, Fulkerson's Rule, Forward & Backward Pass Computation, Floats, problems. **4 Hrs.**

PERT: Time Estimates, Beta and Normal distribution, Probability factor, Slack **4 Hrs.**

Man-material-machinery-money optimization: Cost functions, time –cost trade off, Cost Slope, Crashing problems. **6 Hrs.**

Resource planning, allocation and leveling/smoothening, Resources-based networks, Problems. **6 Hrs.**

Construction Material management: Objectives, purchases management and inventory control systems,

ABC analysis, EOQ model, Problems. **4 Hrs.**

Human Resource management. **2 Hrs.**

Text Books :

1. Construction, Planning and Management by U. K. Shrivastava, Galgotia Publication,N.D-2012

Reference Books :

1. Construction Project Management Planning, Scheduling and Control by Chitkara K.K (Tata Mc Graw Hill N.D 1998)
2. Project Management with CPM, PERT and Precedence Diagramming by Moder. J. (Van Norstrant Reinhold Co-1983)
3. Construction, Planning, Equipments and Methods by R.L. Peurifoy (McGraw Hill)-2011
4. Construction, Planning and Management by Gahlot & Dhir, New Age Publisher- 2010
5. Construction Scheduling with PRIMEVERA Project Planner by Feigenbaum, L. Prentice Hall Inc 1999
6. Principle of Construction Management by Pilcher Mc Graw Hill 1981

CE6239 COMPOSITE STRUCTURES Cr-3

Introduction: definition, Classification and characteristics of Composite materials, advantages and limitations, Current Status and Future Prospects. **4 Hrs.**

Basic Concepts and characteristics: Homogeneity and Heterogeneity, Isotropy, Orthotropy and Anisotropy; Characteristics and configurations of lamina, laminate, micromechanics and macro-mechanics. Constituent materials and properties. **6 Hrs.**

Elastic behaviour of unidirectional lamina: Anisotropic, separately orthotropic and transversely isotropic materials, stress-strain relations for thin lamina, transformation of stress and strain, transformation of elastic parameters. **8 Hrs.**

Strength of unidirectional lamina: Macromechanical failure theories: Maximum stress theory, maximum strain theory, Deviatoric strain energy theory (Tsai-Hill), Interactive tensor polynomial theory (Tsai-Wu) **6 Hrs.**

Elastic Behaviour of multidirectional laminates: Basic assumptions, Stress-strain relations, load deformation relations, symmetric and balanced laminates, laminate engineering properties **6 Hrs.**

Bending and vibration of laminated plates: Governing equations, Deflection of simply supported rectangular symmetric angle-ply, specially orthotropic, anti-symmetric cross-ply laminates. **6 Hrs.**

Composite characterization: Destructive and Non-destructive testing

Text Books

1. Engineering mechanics of Composite materials by I M Daniel and O. Ishai- Oxford university press- 2005

Reference Books:

1. Mechanics of Composite materials by Robert M. Jones- McGraw-Hill Book Company-1975
2. Fiber-reinforced Composites by P.K. Mallick- Marcel Dekker inc- 1993
3. An introduction to composite materials by D. Hull and T W Clyne- Cambridge university press-1996

CE6232 DESIGN OF BRIDGES Cr-3

Introduction, historical review, engineering and aesthetic requirements in bridge design. **4 Hrs.**

Introduction to bridge codes. Economic evaluation of a bridge project, loading standard, IRC specification, Impact factor. **4 Hrs.**

Site investigation and planning;. Scour - factors affecting and evaluation. **2 Hrs**

Bridge foundations - open, pile, well and caisson. Piers, abutments and approach structures-reinforced earth structure; Superstructure - analysis and design of right, skew and curved slabs. **8 Hrs.**

Girder bridges - types, load distribution, design. Orthotropic plate analysis of bridge decks. **6 Hrs.**

Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges. Methods of construction of R.C Bridges, Prestressed concrete bridges and steel bridges Fabrication, Launching & creation. Design and construction of construction joints (use of relevant codes of practice are permitted in the examination). **12 Hrs.**

Text Books:

1. R C Bridges by Tylor, Thomson and Smulki, Khanna Publishers, New Delhi.1988

Reference Books:

1. Foundation of Structures by Dunhan, McGraw-Hill- 1950
2. Foundation of Bridges and Building by Jacoby and davis, , McGraw-Hill- 1953
3. Concrete Bridges, Concrete Association of India
4. Road Bridges- IRS Sec –I , II, III, Manual for standards and specification
5. IRS Codes of Practice for Railway bridges.

CE6234 PRE-STRESSED CONCRETE Cr-3

Different systems of prestressing, Characteristics of concrete and steel, other suitable materials, Losses in prestress. **6 Hrs.**

Analysis and design of section for flexure, shear and torsion. Design of compressive member. Limit state design as per IS code. Introduction to partial prestressing. **4 Hrs.**

Stress distribution in end-block of post tensioned section: Magnel's method, Guyen's method, Rowe's method and IS code method. **4 Hrs.**

Deflection of prestressed structures- short term as well as long term deflections of uncracked and cracked members. **4 Hrs.**

Indeterminate structures- Principles of design of prismatic continuous beams of two and three equal, unequal spans with variable moments of inertia, Composite construction of prestressed and in-situ concrete. **10 Hrs.**

Design of special structures- Circular tanks, Pipes, Mast, and Railway sleepers. **4 Hrs.**

Text Books:

1. Prestressed concrete by N. Krishnaraju- Tata McGraw-Hill, New Delhi-2004.

Reference Books:

1. Prestressed concrete Vol-I & Vol.-II by Y. Guyen- Johnwilley & Sons, New York-1960.
2. Prestressed concrete theory & design by E. W. Bennet- Chapman & Hall, London-1962.
3. Design of prestressed concrete structures by T. Y. Lin & H. Burns Ned, Johnwilley & Sons, New York-1982.
4. Prestressed concrete by S. K. Mallik & A. P. Gupta- Oxford & IBH, New Delhi-1982.

CE6236 DESIGN OF INDUSTRIAL STRUCTURES (OPEN BOOK) Cr-3

Planning of industrial structures, Design of single and multibay industrial structure in steel. **12 Hrs.**

Bunkers and silos. Pressure vessels and Chimneys. Cooling towers, **12 Hrs.**

Large span Roof Structures, Suspension Roof Structures. **12 Hrs.**

Text Books:

1. Design of Steel Structures by A.S. Arya and J.L. Ajmani, Publisher: Nemchand & Bros. Roorkee-2010.

Reference Books

1. Design of Steel Structure by P. Dayaratnam, A.M, Wheeler & Co Allahabad- 2010
2. Design of Steel Structures by B. Bresler, T.Y. Lin & J.B. Scalzi, Publisher: John Wiley, NewYork-1968
3. Design of Steel Structures by E.H. Gaylord and Gaylord, C.N. Charles, International Students Edn., McGraw Hill Book Co., Inc./Kogakusha Co. Ltd. 1975
4. Steel Designer's Manual Crossby Lockwoud, London 1972

CE6238 DESIGN OF OFFSHORE STRUCTURES Cr-3

Oil exploration and production, engineering problems in offshore exploration and production, seabed survey and soil engineering. **6 Hrs.**

Brief introduction to fluid-structure phenomena, Dynamics of progressive waves, diffraction of waves, wave forces on structural system, Morison's equation, Formulation of governing equations of motion for multi-degree freedom systems, Different types of offshore structural systems including submarine pipe lines, review of linear deterministic analysis by superposition and numerical integration procedure. **12 Hrs.**

Introduction to stochastic process and nondeterministic evaluation of the linear nondeterministic response where there in no interaction.. **6 Hrs.**

Techniques of offshore piling for various structures, dynamic stresses in pile driving, soil structure interaction of both jacket and gravity type platforms. Behaviour of a single pile under cyclic lateral loads. Various load situations for jackets as well as piles. **12 Hrs.**

Text Books:

1. An introduction to Ocean Science and Technology by A. K. Malhotra– National book trust India

Reference Books:

1. Dynamic Analysis of offshore structures by C .A. Brebbia and S. Walker - Newnes-Butterwortgs
2. Estuary and Coastline Hydrodynamics by A. T. Ippen– Tata McGrawHill Book Company

CE6242 SOIL-STRUCTURE INTERACTION Cr-3

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour. **12 Hrs.**

Beam on Elastic Foundation- Soil Models: Infinite beam, two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions. **12 Hrs.**

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap. **12 Hrs.**

Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis

Text Book:

1. Foundation Analysis and Design by J E Bowles- Tata-McGraw Hill
2. Elastic Analysis of Soil-Foundation Interaction by Selvadurai, A. P. S Elsevier

Reference Books:

1. Pile Foundation Analysis and Design by Poulos H. G. and Davis E. H.- John Wiley,1980.
2. Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation by E.S.Melersk.
3. Beams of Elastic Foundation by M.Hetenyi, University Michigan Press 1946.

CE6244 OPTIMIZATION TECHNIQUES Cr-3

Introduction: Importance of optimization techniques Linear programming: Formulation, graphical solution, simplex method, Big M Method, Duality, Sensitivity analysis. **10 Hrs.**

Transportation problems: Assignment problems **04 Hrs.**

Decision theory, decision tree, Game theory. **06 Hrs.**

Inventory models – deterministic models probabilistic model. Queuing theory, simulation applications. **10 Hrs.**

Introduction to non linear programming. **04 Hrs**.

Dynamic programming and integer programming, forecasting techniques. **06 Hrs.**

Text Books:

1. Optimization – S. S. Rao, Wiley Eastern Ltd.
2. Operation Research - H. A. Taha, Mac-Millan

Reference Books:

1. Graph Theory – Narsingh Rao, Prentice Hall
2. Operation Research – Wagner, Wiley Eastern Ltd.
3. Project Management – Lick D., Gower Publication England

SCHOOL OF COMPUTER ENGINEERING

SPECIALIZATION: COMPUTER ENGINEERING

CS-6101 ALGORITHMS & COMPLEXITY ANALYSIS CR-4

UNIT-I

Introduction: Algorithms, Analyzing Algorithms, Designing Algorithms **2 Hrs**

Mathematical foundations: Growth of functions, asymptotic notations, Recurrences, Substitution, iteration, master and recursion tree methods, Amortized analysis. **4 Hrs**

Sorting and Order statistics: Heap Sort, Heap property, priority queues, Quick sort, Analysis of quick sort, Randomized version of quick sort, Sorting in linear time, Counting sort, Radix sort, Bucket sort, Medians and order statistics, maximum and minimum. **8 Hrs**

UNIT-II

Dynamic programming: Elements of dynamic programming, Matrix chain multiplication, longest common subsequences. **4 Hrs**

Greedy Algorithms: Elements of the Greedy strategy, Job scheduling, Huffman codes. **4 Hrs**

Graph Algorithms: Elementary graph algorithms, Breadth-first search, Depth-first search, Topological sort, Minimum spanning trees, Kruskal and prims algorithms, Single source shortes path, Dijkstra's algorithm, Bellman-Ford algorithm, All-pairs shortest paths, Floyd-warshall algorithm, flow network. **8 Hrs**

UNIT-III

Branch and bound: Travelling Salesman problem **2 Hrs**

Np-completeness: Polynomial time, Polynomial time verification, Np-completeness and reducibility, Np-completeness proofs and problems. **3 Hrs**

Approximation problem: Vertex cover, TSP. **2 Hrs**

Computational Geometry: Line-segment properties, Segment Intersection, Close structure pair, finding the convex hull. **5 Hrs**

Plynomial and FFT: Representing polynomial, DFT and FFT. **4 Hrs**

String Matching: Robin Karp Algorithm **2 Hrs**

Text Books :

1. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, PHI, Second Edition

References Books:

1. K. Rosen, Discrete Mathematics and its Applications, 4th edition, 2003
2. Jon Kleinberg and Eva Tardos, Algorithm Design, Addison-Wesley, 2006.
3. Aho, Alfred V., John E. Hopcroft, and Jeffrey D. Ullman. ***The Design and Analysis of Computer Algorithms***. Reading, MA: Addison-Wesley, 1974. ISBN: 0201000296.
4. S.Sahani, Data Structures, Algorithms, and Applications in C++, McGraw Hill, NY, 1998

CS-6102 COMPUTATIONAL INTELLIGENCE CR-4

UNIT-I **4 Hrs**

Introduction to Soft Computing: Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy and Soft Computing characteristics.

UNIT-II **12Hrs**

Fuzzy Sets: Introduction, Basic definitions and terminology, Set-theoretic operations, MF Formulation and parameterization, More on fuzzy union, intersection, and complement.
Fuzzy Rules and Fuzzy Reasoning: Extension principle and fuzzy relations, Fuzzy If-Then rules, Fuzzy reasoning.
Fuzzy Inference Systems: Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

UNIT-III **8 Hrs**
Derivative-free optimization: Genetic algorithm, simulated annealing, random search, Downhill simplex search.

UNIT-IV **16Hrs**

Adaptive Networks: Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule.
Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial Basis Function Networks, Modular network.
Learning from reinforcement: Introduction.
Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self-organizing networks, learning vector Quantization, Hebbian learning, principal component networks, and The Hopfield network.

UNIT-V **8 Hrs**

Adaptive Neuro-Fuzzy Inference Systems: ANFIS architecture, Hybrid learning algorithms, learning methods that cross-fertilize ANFIS and RBNF, Simulation examples.

Text Books:

1. Neuro Fuzzy and Soft Computing by J.S.R. Jang, C.T. Sun, E. Mizutani ,PHI, 2009.

Reference Books:

1. Neural Network Design by Martin T Hagan, H B Demuth, M Beale, CENGAGE Learning, India Edition, 2009.
2. Neural Networks and Learning Machines by Simon Haykin, PHI, 2012.
3. Genetic Algorithms in search, Optimization and Machine Learning, 1st Edition by David E. Goldberg, PEARSON, 2004.

CS-6104 MOBILE COMMUNICATION & COMPUTING CR-4

UNIT-I **8 Hrs**

Signal propagation, Multiplexing, Modulation and Spread Spectrum techniques;

UNIT-II ` **12 Hrs**

FDMA, TDMA, CDMA; AMPS, GSM, ECT, UMTS, IMT – 2000; CDMA based cellular system; basic routing, localization and handoff issues;

UNIT-III **12 Hrs**

Packet radio networks, wireless LAN, IEEE 802. 11b, Blue tooth, Wireless ATM; Wireless Application Protocol (WAP) and WML;

U N I T - I V **16 Hrs**

Mobile IP, Ad-hoc networks: AODV, DSR, DSDV routing; Indirect TCP, Snooping TCP,

Mobile TCP, Information Management, location-independent and location-dependent computing models, Mobile applications and services, Security.

Text Books: -

1. Mobile Computing by J. Schiller, 2nd Editiion, 2013.

Reference Books:

1. Mobile Computing by Tomasz Imielinski and F.Korth, Edited By: Springer, 1996.

CS-6121 ADVANCED COMPUTER ARCHITECTURE CR-3

UNIT-I **6 Hrs**

Introduction: - Review of basic computer architecture, quantitative techniques in computer design measuring and reporting performance, CISC and RISC processors;

UNIT-II **8 Hrs**

Pipelining: Basic concepts, instructions and arithmetic pipeline, data hazards, control hazards and structural hazards, techniques for handling hazards, Exception handling, Pipeline optimization techniques;

Hierarchical memory technology: Inclusion, Coherence and locality properties, cache memory organizations, techniques for reducing cache misses, virtual memory organization mapping are management techniques, memory replacement policies;

UNIT-III **10 Hrs**

Instruction-level parallelism: basic concepts, techniques for increasing ILP, super-scalar, super-pipelined and VLIW processor architectures, array and vector processors;

Multiprocessor architecture: Taxonomy of parallel architecture;

UNIT-IV **12 Hrs**

Centralized shared-memory architecture: Synchronization, memory consistency interconnection networks, Distributed shared-memory architecture, Cluster computers, Theory and implementation aspects of distributed operating systems, process synchronization multiprocessing / multiprogramming systems, Inter-process communication and co-ordination large distributed systems; Distributed resource management.

Text Books:

1. Computer Architecture: A Quantitative Approach; Hennessey Patterson, 2012.

Reference Books:

1. K.Hwang and F.A.Briggs, “Computer Architecture and Parallel Processing”, Mc-Graw Hill, 1984.
2. Kai Hwang, “Advanced Computer Architecture: Parallelism, Scalability, programmability”, Mc- Graw Hill, 2008.
3. M.Singhal and N.G.Sivaratri, “Advanced concepts of Operating Systems”, Tata-Mc-Graw Hill Publication, 2005.

CS-6122 CLOUD INFRASTRUCTURE AND SERVICES CR-3

UNIT-I **6 Hrs**

Introduction to Cloud Computing

Definitions, Roots of Cloud Computing: Fundamental concepts of Distributed Systems, Cluster Computing, Grid Computing, and Mobile Computing.

UNIT-II **10 Hrs**

Basics of Cloud Computing

Concepts, Characteristics of Cloud Computing, Need for Cloud, Cloud Deployment models: private, public, hybrid and community cloud, Cloud Services: Resource-as-a-Service (RaaS), Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (PaaS), Examples of each services.

UNIT-III **10 Hrs**

Cloud Services

RaaS: Usage of Physical resources like servers, networks, data center, IaaS: Virtualization, Virtual Machine provisioning and Migration Services, Scheduling techniques of Virtual machines for resource reservation. PaaS: Integrated lifecycle platform: Google App Engine, Microsoft Azure, Anchored life cycle platform: Salesforce platform, SaaS: Characterizing SaaS, Salesforce's software environment.

UNIT-IV **10 Hrs**

Data base as a service (DaaS)

Cloud Data Storage System, CAP theorem Cloud Data Storage services ,Suitability of SQL and NoSQL, Applications of Big Databases, Cloud Security and privacy issues, Mobile Cloud, Integration of Cloud with Wireless Sensor Network and its application.

Text Books:

1. Cloud Computing Principles and Paradigms, RajkumarBuyya, James Broberg and Andrzej Goscinski, Wiley Publication, 2013.

ReferemceBooks:

1. Cloud Computing for Dummies, Judith Hurwitz, Robin Bloor, Marcia Kaufman and Fern Halper, Wiley Publication, 2009.
2. New frontiers in information and software as a service, Divyakant Agrawal, K. G. SelcukCandan, Wen-Syan Li (Eds.), Springer Proceedings, 2011.

CS-6123 DISTRIBUTED COMPUTING CR-3

UNIT-I **6 Hrs**

Models of Computations, Performance metrics. Amdahl's Law – Time Formalism and Brent's Theorem. Parallel Algorithm design Techniques (Parallel Prefix. Pointer Jumping. Divide and Conquer, Symmetry Breaking).

UNIT-II **10 Hrs**

Parallel Algorithm design Techniques: (List Ranking, Euler Tour Technique, Tree Construction). Searching, Merging and Sorting, Introduction to P-completeness. Taxonomy of Parallel Architectures, Dynamic and Static Interconnection Network, Routing Mechanism for Static Networks, Communication cost in static Interconnection Networks.

UNIT-III **8 Hrs**

Cost Performance Tradeoffs, Message Transfer: One –to-All and All – to- All broadcast and Personalized

Communication. Granualrity and Scalability of Parallel Systems. Message Passing: (Asynchronous Message Passing, MPI), Remote Procedure Call.

UNIT-IV **6 Hrs**

Paradigms for Process Interaction (Managers/ Workers, Heartbeat Algorithms, Pipeline Algorithms, Probe/Echo Algorithms, Token Passing Algorithms, Replicated Servers).

UNIT-V **6 Hrs**

Implementations ,Dense Matrix Algorithms: Matrix Transportation & Multiplication. Solution of Linear Systems, Iterative and Direct methods for Spare Linear System.

Text Books:

1. Introduction to paralal Computing, 2nd Edition by ananth, grama, anshul gupta, geroge kanypin, vipin kumar, (Addision Wesely), 2003.

ReferemceBooks:

1. Paralal programming in 'C' with MPI and open MP by Michal J. Quninn Mc Grow Hill

CS-6124 SERVICE ORIENTED ARCHITECTURE CR-3

UNIT-I **8 Hrs**

Introduction to SOA
Service Oriented Analogy, Service Encapsulating Logic, Relationship and Communication in Services, Design and Building of Services, Primitive SOA.
Common Characteristics of SOA
Misperceptions of SOA, Benefits of SOA, Evolution of SOA, Overview & basic Components of SOA.

UNIT-II **10 Hrs**

Principles of Service Orientation
Service Orientation and Enterprise, Anatomy of Service Oriented Architecture, Common Principles of Service Orientation and their Interrelation
Analysis &Designing of SOA
SOA framework, Service-Oriented Analysis, Enterprise oriented SOA, Business service modeling, Service-Oriented Design using UML & Oslo

UNIT-III **10 Hrs**

SOA & Web Services
Web Service Framework, Roles and Models of Services, Web Services at different network layers HTTP, XML, SOAP, WSDL and SAML Standards, Use of XML in SOA, Service Descriptions with WSDL, Messaging with SOAP, Message Exchange Patterns, Service Activity, Coordination, Atomic Transaction, Business Activities, Orchestration and Choreography Addressing, Reliable Messaging Correlation, Policies, Metadata Exchange, Security.

UNIT-IV **8 Hrs**

Service Layers
Service Layer Abstraction, Different Service Layers (Application, Business, Orchestration
Development of a SOA Application
SOA Life Cycle, SOA Governance and its Challenges Current trends in SOA

Text Books:

1. Thomas Erl, Service Oriented Architecture: Concepts Technology and Design, Pearson, 2011

Reference Books:

1. Thomas Erl, SOA Principles of Service Design, Prentice Hall, 1st Edition, 2008
2. Eric A. Marks, Michael Bell, Service Oriented Architecture (SOA): A Planning and Implementation Guide for Business and Technology, John Wiley & Sons, 2006
3. Dirk Krafzig, Karl Banke, Dirk Slama, Enterprise SOA: Service-Oriented Architecture Best Practices, Prentice Hall PTR, 1st edition, 2004
4. Sandeep Chatterjee, James Webber, David Bunnell, "Developing Enterprise Web Services, An Architect's Guide", Pearson Education, 2003.
5. Greg Lomow, Eric Newcomer, Understanding SOA with Web Services, Pearson, 1st Edition, 2005
6. Dan Woods, Thomas Mattern, ENTERPRISE SOA: DESIGNING IT FOR BUSINESS INNOVATION, Shroff/o'reilly, 1st Edition, 2006
7. Thomas Erl, Service-Oriented Architecture, Pearson, 1st Edition, 2007

CS-6125 IMAGE PROCESSING CR-3

UNIT-I **6 Hrs**

Image Transforms Digital Fourier Transform: Fast Fourier Transform, Fast Fourier. Transform, Other Transforms; Convolution, Correlation;

UNIT-II **12 Hrs**

Image Enhancement, Spatial methods, frequency domain method; Image Restoration; geometric transformation; Image Compression: error free and lossy compression; edge detection; Hough transform, region based segmentation;

UNIT-III **10 Hrs**

Image feature/region representation and description: boundary descriptors, region descriptors, morphological operators; Feature based matching, Baye's classification; Low level vision:

UNIT-IV **8 Hrs**

Introduction to stereo sis shape from shading, optical flow; Rule based picture segmentation. Laboratory exercises will emphasize development and evaluation of image algorithms.

Text Books: -

1. Digital Image Processing, 2nd Edition By Gonzalez & Woods, 2004.

Reference Books:

1. Digital Image Processing Algorithms & Applications By Loanmis Pitas, 2000.

CS- 6126 EMBEDDED SYSTEMS CR-3

UNIT – I **10 Hrs**

Introduction: Features of Embedded systems, Design matrices, embedded system design flow, SOC and VLSI circuit. ARM: An advanced Micro Controller, Brief history and ARM pipeline, Instruction Set Architecture ISA: Registers, Data Processing Instructions, Data Transfer Instructions, Multiplications instructions, Software interrupt, Conditional execution, branch instruction, Swap instruction, and THUMB instructions. FPGA

UNIT – II **12 Hrs**

Devices and device drivers, I/O devices, Serial peripheral interfaces, IIC, RS232C, RS422, RS485, Universal serial bus, USB Interface, USB Connector IrDA, CAN, Bluetooth, ISA, PCI, PCI – X and advance busses, Device drivers. Real time operating system: Hard real time, firm real time, soft real time, Task periodicity: periodic task, sporadic task, aperiodic task, task scheduling, scheduling algorithms: clock driven scheduling, event driven scheduling.

UNIT – III **08 Hrs**

Software and programming concept: Processor selection for an embedded system, State chart, SDL, PetriNets, and Unified Modeling Language (UML).
Low power embedded system design: Dynamic power dissipation, Static power dissipation, Power reduction techniques, system level power management.

UNIT-IV **06 Hrs**

Hardware and software partitioning: K-L partitioning, Partitioning uses genetic algorithm, particle swarm optimization, Functional partitioning and optimization: functional partitioning, high level optimizations. Hardware software co-simulations.

Text Books:

1. "Embedded System Design " by Santanu Chattopadhay, PHI , 2013.
2. "Embedded system architecture, programming and design" By Raj Kamal, TMH, 2008.

Reference Books:

1. "Hardware software co-design of Embedded systems" By Ralf Niemann, Kulwer Academic, 1998.
2. "Embedded real time system programming" By Sriram V Iyer, Pankaj Gupta, TMH, 2004.

CS-6128 PATTERN RECOGNITION CR-3

UNIT-I **10 Hrs**

Pattern Recognition : Feature Extraction and classification stages, Different approaches to pattern recognition.

UNIT-II **14 Hrs**

Statistical Pattern Recognition : Hypothesis testing, Linear classifiers, Parametric and nonparametric classification techniques, Unsupervised learning and clustering, Syntactic pattern recognition, Fuzzy set

UNIT-III **12 Hrs**

Theoretic approach to PR, Applications of PR: Speech and speaker recognition, Character recognition, Scene analysis.

Text Books:

1. Pattern Classification., Richard, Duda, Peter Hart and David Stork, Wiley Interscience, 2000, ISBN: 9780471056690

Reference Books:

1. Neural Networks for Pattern Recognition., Christopher, Bishop, Oxford University Press, 1995, ISBN: 9780198538646
2. The Elements of Statistical Learning: Data Mining, Inference and prediction., Hastie, T., R. Tibshirani and J.H Friedman . , NY. Springer, ISBN: 9780387952840, 2009.
3. Information Theory, Interference and learning algorithms., MacKay, David, Cambridge , UK, Cambridge University Press,. ISBN: 9780521642989, 2003.

CS- 6132 GEOGRAPHICAL INFORMATION SYSTEM CR-3

UNIT-I **6 Hrs**

Introduction: Introduction, Definitions of GIS and related terminology, The Evaluation of GIS, Components of GIS, Geospatial data, Spatial data infrastructure**.**

Map language: Introduction, Map as a model, Spatial elements and terminology, Classification of maps, Map scale, Spatial referencing system, Computers in map production, Trends in
computer construction, General software's in map production**.**
Fundamentals of GIS: A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow**.**

UNIT-II **6 Hrs**

Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, Levels of measurement.
Spatial Data Modeling: Introduction; Stages of GIS data modeling; Graphic representation of Spatial Data, Raster data representation, Vector data representation, Spatial data models**; Raster**

UNIT-III **8 Hrs**

GIS models: Types of raster GIS models, Compact raster data models; Vector GIS models, Spaghetti model, Topological model, Shape file, Compact vector data models; Comparison of Raster and Vector Models**.**
GIS Data Management: Introduction, Database management systems: Functions of DBMS, Components of DBMS**;**
GIS data file management: Simple list, Ordered sequential files, Indexed files, Building GIS worlds**;**

UNIT-IV **8 Hrs**
Database models: Hierarchical database models, Network systems, Relational database models, Standard query language (SQL), Storage of GIS data, The hybrid data model, The integrated data model**; Object based data models:** Entity-Relationship-Attribute model, Organizational strategy
of DBMS in GIS.

UNIT-V **8 Hrs**
Data Input, Editing & Quality: Introduction, The data stream, Data input methods: Keyboard entry, Manual digitizing, Scanning and automatic digitizing**;** GPS for GIS data capture, Data editing, Detecting and correcting errors, Data reduction and generalization, Edge matching and Rubbersheeting. Components of data quality. Accuracy, Precision and resolution, Consistency, Completeness, Sources of error in GIS; Modeling errors, Point data error models, Line and area data error models, Models for dot and pixel counting; Error evaluation by graphical methods**.**
GIS Applications:
Remote sensing and GIS Linkage, GIS softwares, Case studies
Text Books:

1. Remote sensing and GIS by M. Anji Reddy, BSP Publications, Hyderabad, 3rd Edition 2008.

References Books:

1. Manual of Geospatial Science and Technology Edited By John. D. Bossler, Taylor And Francis, London, 2004.
2. Geographical Information Systems by Demmeers, 2008.

CS-6134 MACHINE LEARNING CR-3

UNIT-1 **8 Hrs**

Introduction , Linear Clasification, perceptron Update rule, Perceptron convergence, generalization, Maximum Margin classification, Classification errors, regularization, Logistic regression, linear regression,

UNIT-2 **10 Hrs**

Estimator bias and variance , active learning, Non-linear prediction, kernals, kernal regression, Support vector machine(SVM) and kernels, kernel optimization, model selection, Model selection criteria

UNIT-3 **10 Hrs**

Description length, Feature Selection, Combining Classifiers, boosting, margin, and complexity, margin and generalization, mixture models, Mixture and expectation maximization (EM) algorithm, Regularization.

UNIT-4 **8 Hrs**

Clustering, Spectral Clustering, Markov Models, Hidden Markov Models(HMM), Bayesian Networks, Learning Bayesian Networks, Probabilistic inference, Collaborative filtering**.**

Text Book(s):

1. Machine Learning., Mitchell, Tom, McGraw-Hill, ISBN: 97800704280, 3rd Edition.

Reference Books:

1. Neural Networks for Pattern Recognition., Christopher, Bishop, Oxford University Press,1995,ISBN: 9780198538646,
2. Pattern Classification., Richard, Duda, Peter Hart and David Stork, Wiley Interscience, 2000,ISBN: 9780471056690
3. The Elements of Statistical Learning: Data Mining, Inference and prediction., Hastie, T., R. Tibshirani and J.H Friedman . , NY. Springer, ISBN: 9780387952840, 2005.
4. Information Theory, Interference and learning algorithms., MacKay, David, Cambridge ,UK, Cambridge University Press,. ISBN: 9780521642989, 2003.

SCHOOL OF COMPUTER ENGINEERING

SPECIALIZATION: INFORMATION SECURITY

CS-6201 CRYPTOGRAPGHY CR-4

Introduction: Basic objectives of cryptography, secret-key and public-key cryptography, classical cryptography, one-way and trapdoor functions, attack models, Modular arithmetic, gcd, primality testing, Chinese remainder theorem, modular square roots, finite fields. **10 Hrs**

Symmetric-key Ciphers: Modes of operation, DES and its variants, RC5, IDEA, BlowFish, AES, cryptanalysis. **8 Hrs**

Intractable problems: Integer factorization problem, RSA problem, modular square root problem, discrete logarithm problem, Diffie-Hellman problem, known algorithms for solving the intractable problems. **6 Hrs**

Asymmetric-key Ciphers: RSA, Rabin and EIGamal schemes, Diffie-Hellman Key exchange. **6 Hrs**

Message digest, Digital signatures & Entity Authentication: Properties of hash functions, MD5 and SHA-1, keyed hash functions, attacks on hash functions, RSA, DAS and NR signature schemes, Passwords, challenge-response algorithms, zero-knowledge protocols. **8 Hrs**

Network Security: Digital Certificate, public-key infrastructure (PKI), secured socket layer (SSL), Firewall, Email Security, Kerberos. **6 Hrs**

Advanced topics: Elliptic and hyper-elliptic curve cryptography, Quantum cryptograph, DN cryptography. **4 Hrs**

Text Book(s):

1. Cryptography and Network Security, Behrouz A. Forouzan, Tata Mcgraw Hill, 2nd Edition.
2. Cryptography and Network Security, William Stallings, Pearson, 5th Edition.

Reference Book(s)

3. Applied Cryptography, Bruce Schnier, John Wiley & Sons, 2nd Edition.
4. Fundamentals of Computer Security, Josef Pieprzyk, Thomas Hardjono, Jennifer Seberry, Springer, 2003 Edition.
5. Handbook of Applied Cryptography, Alfred J. Menezes, Paul C. van Oorschot, Scott A. Vanstone, CRC Press, 5th Edition.
6. Security in Computing, Charles P. Pfleeger, Shari Lawrence Pfleeger, PHI, 4th Edition.
7. Cryptography: Theory and Practice, Douglas R. Stinson, CRC, 3rd Edition.
8. Foundations of Cryptography, Oded Goldreich, Cambridge University Press, 1st Edition.
9. Elliptic Curves: Number Theory and Cryptography, Lawrence C. Washington, CRC Press, 2nd Edition.
10. Quantum Cryptography and Secret-key Distillation, Gilles Van Assche, Cambridge University Press, 1st Edition

CS-6202 CYBER LAW AND SECURITY POLICIES CR-4

Security and computing: characteristics of computer intrusion - attacks-security goals- criminals-methods of defense control- cryptography- digital signatures-program security - Protection in operating system - design of trusted operating systems. **12 Hrs**

Cyber World and Cyber Law **12Hrs**

1. Cyber World: An Overview

a) The internet and online resources

b) Security of information c. Digital signature

2. An Overview Cyber Law

a) Introduction about the cyber space

b) Regulation of cyber space – introducing cyber law

c) Scope of Cyber laws – e-commerce; online contracts; IPRs (copyright, trademarks and software patenting); e-taxation; e-governance and cyber crimes
d) Cyber law in India with special reference to Information Technology (Amendment) Act, 2008

Information security policies and procedures: corporate policies-legal requirements-business requirements- process management-planning and preparation-developing policies-asset classification policy-developing standards. **8Hrs**

Information security: fundamentals-Employee responsibilities-information classification-Information handling-Tools of information security-Information processing-secure program administration **8Hrs**

Case studies: Organization security model- Information handling procedures-Developing Information standard manual-Information security manual. **8Hrs**

Text Books
1. Cyber Law Duggal Pavan Unversal Law Publishing Co New Delhi, 2013.
2. Willis H Ware, Charles P Pfleeger, Shari Lawrence Pfleeger, "Security in Computing", Prentice Hall, 2003

Reference Books:
1. Thomas R. Peltier, "Information Security policies & procedures: A Practitioner's Reference", 2nd Edition Prentice Hall, 2004
2. Thomas R Peltier, Justin Peltier, John blackley," Information Security Fundamentals", Second Edition, prentice Hall, 1996
3. Jonathan Rosenoer, "Cyberlaw: the Law of the Internet", Springer-verlag, 1997.

CS-6203 INFORMATION THEORY AND CODING TECHNIQUES CR-4

Information Theory: Uncertainty and information, average mutual information and entropy, Perfect secrecy.Source Coding: Source coding theorem, Shannon-Fano coding, Huffman coding, arithmatic coding, Lempel Ziv algorithm, run length coding. **8 Hrs**

Channel capacity & coding: Channel models, channel capacity, channel coding, information capacity theorem, random selection of codes. **6Hrs**
Error control coding: Block codes: single parity check codes, product codes, repetition codes, Hamming codes, minimum distance of codes **5Hrs**

Linear codes: Generator matrices, parity check matrices, error syndromes, error detection and correction, shortened and extended linear codes. **8Hrs**

Cyclic codes: Generator polynomials, encoding and decoding cyclic codes, parity check polynomials, dual cyclic codes, generator and parity check matrices of cyclic codes. **9Hrs**
BCH Codes: Galois fields, Definition & construction of BCH codes, error syndromes in finite fields, RS codes, The Berlekemp algorithm, Error evaluator polynomial. **6Hrs**

Convolution codes: Encoding convolution codes, generator matrices for convolution codes, generator polynomials for convolution codes, The viterbi decoder, Tree codes, Turbo codes, Trellis codes. **6 Hrs**

Text Books:

Ranjan Bose, "Information Theory, Coding and Cryptography", TMH, 2011.

Reference Books:

1. Salvatore Gravano "Introduction to Error Control Codes", Oxford, 2001.
2. Wade Trape, Lawrence C Washington, "Introduction to Cryptography with Coding Theory", Pearson, 2011.

CS-6221 DATA AND KNOWLEDGE SECURITY CR-3

Data Security: Database systems- architectures- storage structures- storage issues in in Database Management Systems- Security of data at various levels of Database Management Systems **5Hrs**

Distributed Databases: Distributed Data Processing- Distributed Database system- Distributed Database Management System Architecture: Architectural models for Distributed Database Management System – Global directory issues – Distributed database design – distributed design issues – fragmentation – Allocation **7 Hrs**

Semantic Data Control: View Management – Data centralized Authorization control – Distributed Authorization control – centralized Semantic Integrity Control - Centralized Semantic Integrity Control - Database interoperability - issues related to security in database interoperability **7 Hrs**

UNIT IV

Knowledge base systems - Knowledge base system design – storage of knowledge – various formats – Levels of security issues in Knowledge base system design – conceptual level – implementation level **10 Hrs**

UNIT- V

Expert Systems – Design of Expert systems – Knowledge representation techniques in Expert system – structured, semi structured and unstructured data – Knowledge Management and security issues. **7 Hrs**

Text Books:

1. Security in Computing, Charles P. Pfleeger and Shari Lawrence Pfleeger, Third Edition, Pearson Education, 2003.

Reference Books:

2. Principles of Distributed Database Systems, M.Tamer OZSU and Patrick Valdureiz, Second Edition , Pearson Education, 2001.
3. Artificial Intelligence: A Modern approach, Stuart Russel and Peter Norwig, Third Edition, Pearson Education, 2003.
4. Knowledge Management, Ganesh Natarajan and Sandhya Shekhar, Tata McGrawHill, 2000.

CS-6222 MOBILE WIRELESS SECURITY CR-3

Wireless Fundamentals : Wireless Hardware- Wireless Network Protocols- Wireless Programming WEP Security. Wireless Cellular Technologies – concepts – Wireless reality – Security essentials – Information classification standards - Wireless Threats : Cracking WEP - Hacking Techniques- Wireless Attacks – Airborne Viruses. **8 Hrs**

Standards and Policy Solutions – Network Solutions – Software Solutions – Physical Hardware Security- Wireless Security – Securing WLAN – Virtual Private Networks – Intrusion Detection System – Wireless Public Key infrastructure.. Tools – Auditing tools – Pocket PC hacking – wireless hack walkthrough. **7 Hrs**

Security Principles – Authentication – Access control and Authorization – Non-repudation- privacy and Confidentiality – Integrity and Auditing –Security analysis process. Privacy in Wireless World – Legislation and Policy – Identify targets and roles analysis – Attacks and vulnerabilities – Analyze mitigations and protection. **7 Hrs**

WLAN Configuration – IEEE 802.11 – Physical layer – media access frame format – systematic exploitation of 802.11b WLAN – WEP – WEP Decryption script – overview of WEP attack – Implementation - Analyses of WEP attacks. **7 Hrs**

Mobile Commerce Security and Payment Methods – Reputation and Thrust – Intrusion detection - Vulnerabilities analysis of mobile commerce platform – Secure authentication for mobile users – Mobile Commerce security – Payment methods – Mobile Coalition key evolving Digital Signatures scheme for wireless mobile networks. **7 Hrs**

Text book(s):

1. Anurag Kumar, D. Manjunath, Joy Kuri “Wireless Networking” Morgan Kaufmann Publihsers, First Edition – 2009.

Reference books:

1. Russel Dean Vines,"Wireless Security Essentials: Defending Mobile from Data Piracy", John Wiley & Sons, First Edition – 2002.
2. Cyrus, Peikari, Seth Fogie, "Maximum Wireless Security", SAMS Publishing 2002.
3. Wen Chen hu, Chang Wiu Lee, Weidong kou, "Advances in Security and Payment Methods for Mobile Commerce", Idea Group Inc-2004**.**

CS-6223 INTRUSION DETECTION SYSTEM CR-3

Introduction to data and methodologies of computer intrusion detection, statistical & machine approaches to detection of attacks on computer, techniques for studying the Internet & estimating the number & severity of attacks, network based attacks such as probes & denial of service attacks, host based attacks such as buffer overflows and race conditions, malicious codes such as virus and worms, statistical pattern recognition for detection & classification of attacks, techniques for visualizing networked data etc. Special topics in intrusion detection systems. **9 Hrs**

Ethics and legality - Footprinting - Scanning - Enumeration - System Hacking - Trojans and Back doors - Sniffers - Social Engineering - Session hijacking - Hacking Web Servers - Web based Password cracking techniques - Wireless Hacking - SQL Injection - Linux Hacking - Buffer overflows - Evading IDS, Honeypots and Firewalls. **8 Hrs**

Components of an IDS , Characterstics of an IDS, Detection Model, Scope & Operation of IDS, Goals of an IDS, Types of IDS,Architecture of IDS, Centralized IDS Architecture, Distributed IDS Architecture, Hierarichal IDS Architecture. **9Hrs**

Introduction to intrusion detection tools and techniques, Stream Reassembly, Traffic Normalization, Feature equality heuristics, genetic programming and other researched IDS techniques, Technical issues, Legal issues related to testing, use and deployment of an IDS, Organizational and management issues **5 Hrs**

IDS Today and Tomorrow, Reality with no IDS, Review of Current research related to IDS **5 Hrs**

Text Books:-

1. Web Hacking, S. McClure, S.Shah, Shreeraj Shah, 1st Edn, Pearson Press, 2002.
2. The Database Hacker's Handbook, D. Litchfield, C. Anley J. Heasman, B. Grindlay, 1st Edn Wiley Publishers, 2005.

Reference Books:

1. Gray Hat Hacking: The Ethical Hacker's Handbook, Shon Harris, Allen Harper, Chris Eagle, Jonathan Ness, 3rd Edn, McGraw Hill-Osborne Media, 2011.
2. CEH: Official Certified Ethical Hacker Review Guide, Kimberly Graves, Pap/ Cdr Re, Wiley Publishing Inc., 2007
3. Hands-on Ethical Hacking and Network Defense, Michael T. Simpson, Kent Backman, James Corley, 2nd Edn, Course Techn, 2010.

CS 6224 BIOMETRIC SECURITY CR 3

Biometrics- Introduction- benefits of biometrics over traditional authentication systems-benefits of biometrics in identification systems-selecting a biometric for a system- **8 Hrs**

Applications. Key biometric terms and processes-how biometric matching works-Accuracy in biometric systems

Physiological Biometric Technologies: Fingerprints- Technical description-characteristics- Competing technologies-strengths – weaknesses-deployment. Facial scan - Technical description-characteristics- weaknesses-deployment. Iris scans - Technical description-characteristics- strengths – weaknesses-deployment. Retina vascular pattern-Technical description-characteristics- strengths – weaknesses-deployment. Hand scan - Technical description-characteristics- strengths – weaknesses-deployment –DNA biometrics **7 Hrs**

Behavioral Biometric Technologies: Handprint Biometrics-DNA Biometrics-signature and handwriting technology-Technical description – classification- keyboard /keystroke dynamics -Voice – data acquisition- feature extraction-characteristics- strengths – weaknesses-deployment **8 Hrs**

Multi biometrics: Multi biometrics and multi factor biometrics- two-factor authentication with passwords, tickets and tokens –executive decision- implementation plan **7 Hrs**

Case studies on Physiological, Behavioral and multifactor biometrics in identification systems. **7 Hrs**

Text book(s):

1. Samir Nanavathi, Michel Thieme, Raj Nanavathi,"Biometrics -Identity verification in a network", WileyEastern, 2002.
2. John Chirillo and Scott Blaul," Implementing Biometric Security", Wiley EasternPublications, 2005.

Reference Books:

1. John Berger," Biometrics for Network Security", Prentice Hall, 2004.

CS-6225 DIGITAL FORENSICS CR-3

Computer Forensics Fundamentals: What is computer Forensics?, Use of computer Forensics in Law Enforcement, Computer Forensics Assistance to Human Resources/Employment Proceedings, Computer Forensics Services, Benefits of Professional Forensics Methodology, Steps taken by Computer Forensics Specialists **5 Hrs**

Types of Computer Forensics Technology: Types of Military Computer Forensic Technology, Types of Law Enforcement- Computer Forensic Technology- Types of Business Computer Forensic Technology **9 Hrs**

Computer Forensics Evidence and Capture: Data recovery Defined- Data Back-up and Recovery- The Role of Back-up and Data Recovery- The Data Recovery Solution

Evidence Collection and Data Seizure: Why Collect Evidence? Collection Options – Obstacles – Types of Evidence – The Rules of Evidence – Volatile Evidence – General Procedure – Collection and Archiving – Methods of Collection – Artifacts – Collection Steps – Controlling Contamination: The Chain of Custody Duplication and Perservation of Digital

Evidence: Preserving the Digital Crime Scene – Computer Evidence Processing Steps – Legal Aspects of Collecting and Preserving Computer Forensic Evidence Computer Image Verification and Authentication: Special needs of Evidential Authentication – Practical Consideration – Practical Implementation **7 Hrs**

Computer Forensic analysis and validation: Determining what data to collect and analyze, validating forensic data, addressing data – hiding techniques, performing remote acquisitions

Network Forensics: Network forensics overview, performing live acquisitions, developing standard procedures for network forensics; unsing network tools, examining the honeynet project. **9 Hrs**

Processing Crime and Incident Scenes: Identifying digital evidence, collecting evidence in private-sector incident scens, processing law enforcement crime scenes, preparing for a search, securing a computer incident or crime scene, seizing digital evidence at the scene, storing digital evidence, obtaining a digital hash, reviewing a case Current Computer Forensic tools: evaluating computer forensic tool needs, computer forensic software tools, computer forensic hardware tools, validating and testing forensics software. **9 Hrs**

E – Mail Investigations: Exploring the role of e-mail in investigation, exploring the roles of the client and server in e-mail, investigating e-mail crimes and violations, understanding e-mail servers, using specialized e-mail forensic tools Cell phone and mobile device forensics: Understanding mobile device forensics, understanding acquisition procedures for cell phones and mobile devices.

Working with Windows and DOS Systems: understanding file systems, exploring Microsoft File Structures, Examining NTFS disks, Understanding whole disk encryption, windows registry, Microsoft startup tasks, MS-DOS startup tasks, virtual machines. **6 Hrs**

Text books:

1. Computer Forensics, Computer Crime Investigation by John R. Vacca, Firewall Media, New Delhi, 2005.
2. Computer Forensics and Investigations by Nelson, Phillips Enfinger, Steuart, CENGAGE Learning, 2009.

Reference books:

1. Real Digital Forensics by Keith J. Jones, Richard Bejtlieh, Curtis W. Rose, Addison – Wesley Pearson Education, 2005.
2. Forensic Compiling. A Tractitioneris Guide by Tony Sammes and Brain Jenkinson, Springer International edition, 2010.
3. Computer Evidence Collection & Presentation by Christopher L.T.Brown, Firewall Media, 2007.
4. Homeland Security, Techniques & Technologies by Jesus Mena, Firewall Media., 2007.
5. Software Forensics Collecting Evidence from the scene of a Digital Crime by Robert M.Slade, TMH 2005

CS-6226 STEGANOGRAPHY AND DIGITAL WATERMARKING CR-3

Introduction to Information hiding – Brief history and applications of information hiding – Principles of Steganography – Frameworks for secret communication – Security of Steganography systems –Information hiding in noisy data – Adaptive versus non adaptive algorithms – Laplace filtering – Using cover models – Active and malicious attackers – Information hiding in written text – Examples of invisible communications. **7 Hrs**

Survey of steganographic techniques – Substitution system and bitplane tools – Transform domain techniques – Spread spectrum and information hiding – Statistical Steganography - Distortion and code generation techniques – Automated generation of English text. **8 Hrs**

Steganalysis – Detecting hidden information – Extracting hidden information - Disabling hidden information – Watermarking techniques – History – Basic Principles – applications – Requirements of algorithmic design issues – Evaluation and benchmarking of watermarking system. **7 Hrs**

Survey of current watermarking techniques – Cryptographic and psycho visual aspects – Choice of a workspace – Formatting the watermark bets - Merging the watermark and the cover – Optimization of the watermark receiver – Extension from still images to video – Robustness of copyright making systems **7 Hrs**

Fingerprints – Examples – Classification – Research history – Schemes – Digital copyright and watermarking – Conflict of copyright laws on the internet. **7 Hrs**

Text book:

1. Stefan Katzenbelsser and Fabien A. P. Petitcolas, Information hiding techniques for Steganography and Digital Watermarking, ARTECH House Publishers, January 2004.

Reference book:

1. Multimedia Security: Steganofraphy and Digitial water marking techniques for protection of Intellectnal property, Chun shienlk, Idea group publishing, 2005.
2. Techniques and Applications of Digital Watermarking and content protection, Michel Arnold, Martin, Shemuckev, Stephen, D. Wolfhusen artech house, 2003.

CS-6228 PERFORMANCE EVALUATION OF INFORMATION SYSTEM CR-3

UNIT-I **18 Hrs**

Introduction to performance measures, performance measurement, analytical modeling for performance, use of basic probability for performance evaluation.

UNIT-II **18 Hrs**

Markov chains, Markovian queues, non-Markovian queues, queueing networks, simulation modeling and analysis (confidence intervals). Examples from operating systems (paging, CPU-disk models), from networks: Web, TCP/IP models.

Text Books:-

1. Probability and Statistics with Reliability, Queueing and Computer Science Applications, 2nd edition, by Kishor Trivedi, John Wiley&Sons, 2002.

Reference Books:

1. Teletraffic : theory and applications, by Akimaru and Kawashima, Springer-Verlag, 1993
2. The Practical Performance Analyst, by Neil Gunther, iUniverse.com, 2000.
3. Queueing Systems vol I & II, by L. Kleinrock, John Wiley and Sons, 1975.

SCHOOL OF COMPUTER ENGINEERING

SPECIALIZATION: DATA ANALYTICS

CS-6301 DATA WAREHOUSING AND DATA MINING CR-4

Data Warehousing:

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. **9Hrs**

Business Analysis:

Reporting and Query tools and Applications – Tool Categories – The Need for Applications – Cognos Impromptu – Online Analytical Processing (OLAP) – Need –Multidimensional Data Model – OLAP Guidelines – Multidimensional versus Multirelational OLAP – Categories of Tools – OLAP Tools and the Internet. **9Hrs**

Data Mining:

Introduction – Data – Types of Data – Data Mining Functionalities – Interestingness of Patterns – Classification of Data Mining Systems – Data Mining Task Primitives –Integration of a Data Mining System with a Data Warehouse – Issues – Data Preprocessing. **10Hrs**

Association Rule Mining and Classification:

Mining Frequent Patterns, Associations and Correlations – Mining Methods – Mining Various Kinds of Association Rules – Correlation Analysis – Constraint Based Association Mining – Classification and Prediction - Basic Concepts - Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction. **10Hrs**

Clustering and Applications 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. **10Hrs**

Text Books:

1. *Data Mining Concepts and Techniques*, Jiawei Han and Micheline Kamber, Jian Pei, Third Edition, Elsevier, 2012.

Reference Books:

1. *Data Warehousing, Data Mining & OLAP*, Alex Berson and Stephen J. Smith ,Tata McGraw – Hill Edition, Thirteenth Reprint, 2008.
2. *Introduction To Data Mining*, Pang-Ning Tan, Michael Steinbach and Vipin Kumar,,Person Education, 2007.
3. *Insight into Data mining Theory and Practice*, Soman K.P., Shyam Diwakar and V. Ajay, Easter Economy Edition, Prentice Hall of India, 2006.
4. *Introduction to Data Mining with Case Studies*, Gupta G. K., Easter Economy Edition, Prentice Hall of India, 2006.
5. *Data Mining Methods and Models*, Daniel T. Larose ,Wile- Interscience, 2006.

CS-6302 BIG DATA ANALYTICS CR-4

Introduction: Introduction of Data Science-Getting started with R- Exploratory Data Analysis- Review of probability and probability distributions- Bayes Rule Supervised Learning- Regression- polynomial regression- local regression- nearest neighbors. **10Hrs**

Unsupervised Learning:

Unsupervised Learning- Kernel density estimation- k-means- Naive Bayes- Data and Data Scraping Classification-ranking-logistic regression .Ethics- time series advanced regression- Decision trees- Best practices- feature selection. **8Hrs**

Big Data from Different Perspectives:

Big data from business Perspective: Introduction of big data-Characteristics of big data-Data in the warehouse and data in Hadoop- Importance of Big data- Big data Use cases: Patterns for Big data deployment. Big data from Technology Perspective: History of Hadoop-Components of Hadoop-Application Development in Hadoop. **12Hrs**

Infosphere Biginsight:

Infosphere Big Insights: Analytics for Big data at rest-A Hadoop –Ready Enterprise-Quality file system-Compression – Administrative tooling-Security- Enterprise Integration –Improved workload scheduling-Adaptive map reduce-Data discovery and visualization-Machine Analytics **10Hrs**

Infosphere Streams:

Infosphere Streams: Analytics for Big data in motion- Infosphere Streams Basicsworking of Infosphere Streams-Stream processing language-Operators-Stream toolkits-Enterprise class. **8Hrs**

Text Books:

1. *Understanding Big Data: Analytics for Enterprise Class Hadoop and streaming Data"*, Paul Zikopoulos, Chris Eaton , Paul Zikopoulos, The McGraw-Hill Companies, 2012.

Reference Books:

1. *A Simple Introduction To Data Science*, Noreen Burlingame and Lars Nielsen, New Street Communications,2013.

CS-6303 DATABASE DESIGN CR-4

Database System Architecture: Centralized and Client Server Architecture, Server System Architecture, Parallel System, Distributed Systems. **8Hrs**

Conceptual & Logical Database Design: Conceptual Design Model: Database design process models, ER (Entity-Relationship) model, Extended E-R features, reduction to Relational Schemas, Conceptual Modeling using UML diagram, Logical database Design: Informal Design guidelines for Relational Schemas, Functional Dependency Theory, Normalizations, and Algorithms for Relational Database Schema Design, Multi-valued and Dependency, Join Dependency. **14Hrs**

Physical Database Design: Goals of physical database design; File organization: Heap, Sequential, hash, index file organizations, Tree-Structured indexes, Data Storage Devices, Redundant Array of Inexpensive Disk (RAID) **10Hrs**

Object-Based Databases: Complex Data types, Object Orientation, Table Inheritance, Array & Multiset Types, Implementing Object Oriented Features, XML database: Structure, Schema, Querying, Storage & Applications. **8Hrs**

Transaction Processing: Transaction Processing, Graph-based serializability and Non-graph based serializability, Database Recovery. **8Hrs**

Text Books:

1. S.Sumathi, S. Esakkirajan, "Fundamentals of Relational Database Management Systems", Springer-Verlag Berlin Heidelberg, Indian Print, 2008.
2. Narayan S. Umanath, Richard W. Scamell, "Data Modeling and Database Design", Thomson India Edition, 2006

Reference Books:

1. Ramez Elmasri, Shamkant B. Navathe, Durvasula V.L.N. Somayajulu, Shyam K. Gupta," Fundamentals of Database Systems", Pearson Education,2006
2. Abraham Silberschatz, Henry F. Korth, S. Suderson, "Database System Concepts", 5th Edition, McGRAW-HILL International Edition, 2006

CS- 6321 INFORMATION STORAGE & MANAGEMENT CR-3

Introduction to Information Storage and Management: Information Storage, Evolution of Storage Technology and Architecture, Data Center Infrastructure, Key Challenges in Managing Information, Information Lifecycle. Storage System Environment: Components of a Storage System Environment, Disk Drive Components, Disk Drive Performance, Fundamental Laws Governing Disk Performance, Logical Components of the Host, Application Requirements and Disk Performance. Data Protection: RAID: Implementation of RAID, RAID Array Components, RAID Levels, RAID Comparison, RAID Impact on Disk Performance, Hot Spares. Intelligent Storage System: Components of an Intelligent Storage System, Intelligent Storage Array. **8Hrs**

Storage Networking Technologies and Virtualization: Types of DAS, DAS Benefits and Limitations, Disk Drive Interfaces, Introduction to Parallel SCSI, SCSI Command Model. Storage Area Networks: Fiber Channel: Overview, The SAN and Its Evolution, Components of SAN, FC Connectivity, Fiber Channel Ports, Fiber Channel Architecture, Zoning, Fiber Channel Login Types, FC Topologies. Network-Attached Storage: General-Purpose Servers vs. NAS Devices, Benefits of NAS, NAS File I/O, Components of NAS, NAS Implementations, NAS File-Sharing Protocols, NAS I/O Operations, Factors Affecting NAS Performance and Availability. IP SAN: iSCSI, FCIP. Content-Addressed Storage: Fixed Content and Archives, Types of Archives, Features and Benefits of CAS, CAS Architecture, Object Storage and Retrieval in CAS. Storage Virtualization: Forms of Virtualization, SNIA Storage Virtualization Taxonomy, Storage Virtualization Configurations, Storage Virtualization Challenges, Types of Storage Virtualization. **12Hrs**

Backup and Recovery: Backup Purpose, Backup Considerations, Backup Granularity, Recovery Considerations, Backup Methods, Backup Process, Backup and Restore Operations, Backup Topologies, Backup in NAS Environments, Backup Technologies. Local Replication: Source and Target, Uses of Local Replicas, Data Consistency, Local Replication Technologies, Restore and Restart Considerations, Creating Multiple Replicas, Management Interface. Remote Replication: Modes of Remote Replication, Remote Replication Technologies, Network Infrastructure. **10Hrs**

Securing the Storage Infrastructure: Storage Security Framework, Risk Triad, Storage Security Domains, Security Implementations in Storage Networking. Managing the Storage Infrastructure: Monitoring the Storage Infrastructure, Storage Management Activities, Storage Infrastructure Management Challenges, Developing an Ideal Solution. **6Hrs**

Text Books:

1. Information Storage and Management: Storing, Managing, and Protecting Digital Information, G. Somasundaram; Alok Shrivastava, John Wiley & Sons,2nd Edition, 2009

CS-6322 KNOWLEDGE REPRESENTATION & REASONING CR-3

Introduction: Including example problems, problem representation via logic, computer assisted reasoning in mathematics. Elementary set theory: What is a set, a relation, a function, set operations (intersection, union, etc), properties of binary relations (reflexivity, symmetry, transitivity, etc). Propositional logic: Theory, language, models, validity and satisfiability, inference rules, soundness and completeness, reasoning methods: truth tables, proof by contradiction. First-order logic: First order logic formulae, their meaning, validity and satisfiability, translating between natural language and first-order logic. Early knowledge representation formalisms: Nonmonotonic inheritance networks, frame-based systems. First-Order Logic: First order logic formulae, their meaning, reasoning problems, useful normal forms, inference calculus, undecidability and semi-decidability. **14Hrs**

Modal Logic: Representation and reasoning on the semantical level: Modal logic, possible worlds semantics, model checking, satisfiability and validity, correspondence theory. Modal Logic: Reasoning calculi, agent applications: Logically omniscience problem, belief logic, epistemic logic, deduction in Hilbert systems, deduction via translation to first-order logic. Description logics: Language of description logics, meaning of description logic statements, reasoning calculi, introduction to the semantic web and ontologies using description logics. Icom: EER diagrams, relationship between EER diagram and description logic, reasoning about EER diagrams. **14Hrs**

Non-standard reasoning services in description logics: Least common subsumers, most specific concepts, and their usage in description logic applications. Temporal logic: The temporal logic LTL, its extension to temporalised modal and description logics, their applications. Defaults, in propositional and first order logic: Defaults, motivation for ordered defaults, e.g. in description logics, their applications. **8Hrs**

Text Books:

1. Theory, implementation & applications, Baader, Franzetal (eds.),ISBN:0521781760 Cambridge University Press 2003 Edition.

Reference Books:

1. Logic in Computer Science: modelling and reasoning about systems, Huth, Michael and Mark Ryan, ISBN: 052154310X, Cambridge University Press 2nd Edition,2004

CS-6323 M-COMMERCE CR-3

ELECTRONIC COMMERCE:

Introduction – The e- commerce environment – The e-commerce marketplace – Focus on portals, Location of trading in the marketplace - Commercial arrangement for transactions – Focus on auctions – Business models for e-commerce – Revenue models – Focus on internet start – up companies – the dot – com – E-commerce versus E-business. **8 Hrs**

MOBILE COMMERCE: Introduction – Infrastructure Of M–Commerce – Types Of Mobile Commerce Services – Technologies Of Wireless Business – Benefits And Limitations, Support, Mobile Marketing & Advertisement, Non – Internet Applications In M–Commerce – Wireless/Wired Commerce Comparisons **6 Hrs**

MOBILE COMMERCE: TECHNOLOGY:A Framework For The Study Of Mobile Commerce – NTT Docomo's I – Mode – Wireless Devices For Mobile Commerce – Towards A Classification Framework For Mobile Location Based Services – Wireless Personal And Local Area Networks – The Impact Of Technology Advances On Strategy Formulation In Mobile Communications Networks **6 Hrs**

MOBILE COMMERCE: THEORY AND APPLICATIONS: The Ecology Of Mobile Commerce – The Wireless Application Protocol –Mobile Business Services – Mobile Portal – Factors Influencing The Adoption Of Mobile Gaming Services – Mobile Data Technologies And Small Business Adoption And Diffusion – M–Commerce In The Automotive Industry – Location – Based Services: Criteria For Adoption And Solution Deployment – The Role Of Mobile Advertising In Building A Brand – M–Commerce Business Models **8 Hrs**

BUSINESS – TO – BUSINESS MOBILE E-COMMERCE: Enterprise Enablement – Email And Messaging – Field Force Automation (Insurance, Real Estate, Maintenance, Healthcare) – Field Sales Support (Content Access, Inventory) – Asset Tracking And Maintenance/Management – Remote IT Support – Customer Retention (B2C Services, Financial, Special Deals) – Warehouse Automation – Security. **8 Hrs**

Text Books:

1. Dave Chaffey, "E-Business and E-Commerce Management", Third Edition, 2009, Pearson Education

Reference Books:

1. Brian E. Mennecke, Troy J. Strader, "Mobile Commerce: Technology, Theory and Applications", Idea Group Inc., IRM press, 2003.
2. P. J. Louis, " M – Commerce Crash Course", McGraw – Hill Companies February 2001.
3. Paul May, "Mobile Commerce: Opportunities, Applications, and Technologies of Wireless Business" Cambridge University Press March 2001.
4. Michael P. Papazoglou, Peter M.A. Ribbers, 'e – business organizational and Technical foundation ',Wiley India 2009
5. Dr.Pandey , Saurabh Shukla E-commerce and Mobile commerce Technologies , Sultanchand ,2011

CS-6324 DISTRIBUTED & PARALLEL DATABASE CR-3

Overview of Query Optimization: SQL overview, Query processor, Cost estimation, Query processing, Need for Query Optimization, Query optimization Techniques. **4 Hrs**

Parallel Database: Parallel system architectures, Parallel data processing, Barrier to parallelism, Data partitioning strategies, Data placement strategies, Parallel algorithms, Commercial Systems. **6 Hrs**

Parallelizing query optimization techniques: Optimization strategies, Parallelizing query optimizer, Parallelizing individual operations, System architecture, basic concepts of load balancing strategy and performance evaluation. **6 Hrs**

Introduction to Distributed databases: Distributed data processing, Distributed Database Management systems, Advantages & Disadvantages, Architecture, Data Fragmentation, Replication, Distribution Transparency, Distributed Database Design. **6 Hrs**

Query Processing: Characteristics & Layers of query processors, Query decomposition, Localization of distributed data, Optimizing distributed queries, ordering of fragment queries, Optimization algorithms for distributed query processing. **6 Hrs**

Distributed Transaction Management: Transaction Management, Transaction Models, Atomicity management of distributed transactions, Concurrency control for distributed transactions, Architectural aspects of distributed transactions. Distributed deadlocks, Distributed recovery, Distributed reliability protocols, Concurrency control based on timestamps. **8 Hrs**

Text Books:

1. Distributed Databases Principles and Systems, S. Ceri & G. Pelagatti, Mc Graw Hill,1984
2. Principles of Distributed Database Systems, M. T. Ozsu & P. Valduriez, Pearson,2006

References Books:

1. Distributed Database Management Systems: A Practical approach, S. K. Rahimi & F. S. Haug, Wiley, 2010.
2. Location-Based Services Handbook: Applications, Technologies & Security, S. A. Ahson & M. Ilyas, CRC press,2010

CS- 6325 INFORMATION RETRIEVAL CR-3

Introduction: Definition, Objectives, Functional Overview, Principles of Information Retrieval , Relationship to DBMS, Digital libraries and Data Warehouses. Information Retrieval System Capabilities: Search, Browse, Miscellaneous. Cataloging and Indexing: Objectives, Indexing Process, Automatic Indexing, Information Extraction. **8Hrs**

Data Structures: Introduction, Zipfs Law, Vector space model, cosine similarity. Scoring techniques, Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure, Signature file structure, and Hypertext data structure. **6Hrs**

Automatic Indexing: Classes of automatic indexing, Statistical indexing, Natural language, Concept indexing, Hypertext linkages, Document and Term Clustering: Introduction, Thesaurus generation, Item clustering, Hierarchy of clusters. **6Hrs**

User Search Techniques: Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, weighted searches of Boolean systems, Searching the internet and hypertext, Information Visualization: Introduction, Cognition and perception, Information visualization technologies. **10Hrs**

Text Search Algorithms: Introduction, Software text search algorithms, Hardware text Search Systems. Information System Evaluation: Introduction, Measures used in system evaluation, Measurement example – TREC results. **6Hrs**

Text Books:

1. Information Retrieval Data Structures and Algorithms, Frakes, W.B., Ricardo Baeza-Yates, Prentice Hall,2006

Reference Books:

1. Information Retrieval Systems: Theory and Implementation, Kowalski, Gerald, Mark T Maybury, Kluwer Academic Press.,2010
2. Introduction to Information Retrieval, P Raghavan, M Manning and P Schutze, Cambridge University Press, 2008
3. Modern Information Retrieval, Yates, Pearson Education.2008
4. Information Storage & Retieval, Robert Korfhage John Wiley & Sons, 2012.

CS-6326 DATABASE IMPLEMENTATION & TUNING CR-3

Fundamentals of Tuning: Review of Relational Databases, Relational Algebra, Query Optimization in Relational database System, Locking and Concurrency Control, Correctness Consideration, Lock Tuning, Logging and the Recovery subsystem, Principles of Recovery, Tuning the Recovery subsystem, Operating system considerations, Hardware Tuning. **8 Hrs**

Index Tuning: Types of Queries, Data structures, B tree, B^+ tree, Hash structure, Bit map indexes, Clustering indexes, Non-clustering indexes, Composite indexes, Hot tables, Comparison of Indexing and Hashing techniques. **6 Hrs**

Query Optimization: Techniques, Tuning Relational systems, Normalization, Tuning Denormalization, Clustering two tables, Aggregate maintenance, Record layout, Query tuning, Triggers, Client server mechanisms, Objects, Application tools and performance, Tuning the application interface, Bulk loading data, Access multiple databases. **8 Hrs**

Troubleshooting: Query plan explainers, Performance monitors, Event monitors, Finding Suspicious queries, Analyzing a Query's Access plan, Profiling a query execution, DBMS subsystem. **6 Hrs**

Case Studies: Transaction chopping, Time series databases, Understanding access plans, Configuration parameters: Oracle, SQL server, DB2, Distributed database, Implementation. **8Hrs**

Text Books:

1. Database Tuning, Principles, Experiments and Troubleshooting Techniques, Dennis Shasha and Philippe Bonnet, Morgan Kaufmann, An Imprint of Elsevier 2003.

Reference Books:

1. Database Systems, A Practical Approach to Design, Implementation and Management, Thomas Connoly and Carlolyn Begg, 3rd edition, Pearson Education 2003
2. Automated Physical Database Design and Tuning, Nicolas Bruno, CRC Press

CS-6327 ENTERPRISE SYSTEMS CR-3

Introductin to ERP:
Integrated Management Information Seamless Integration – Supply Chain Management Integrated Data Model – Benefits of ERP – Business Engineering and ERP – Definition of Business Engineering – Principle of Business Engineering – Business Engineering with Information Technology. **10 Hrs**

Business Modelling for ERP:
Building the Business Model – ERP Implementation – An Overview – Role of Consultant, Vendors and Users, Customization – Precautions – ERP Post Implementation Options-ERP Implementation Technology –Guidelines for ERP Implementation. **8 Hrs**

ERP and the Competitive Advantage ERP domain MPGPRO – IFS/Avalon – Industrial and Financial Systems – Baan IV SAP-Market Dynamics and Dynamic Strategy **6 Hrs**

.Commercial ERP Package : Description – Multi-Client Server Solution – Open Technology – User Interface- Application Integration. **6 Hrs**

Architecture : Basic Architectural Concepts – The System Control Interfaces – Services – Presentation Interface – Database Interface - Cases. **8 Hrs**

Text Books:

1. Enterprise Resource Planning – Concepts and Practice, Vinod Kumar Garg and N.K.Venkita Krishnan PHI, 1998.

Reference Books:

1. The SAP R/3 Handbook, Jose Antonio Fernandz, TMH, 1998.
2. Enterprise Resource Management, Lau R.S.M, McGraw Hill,2005
3. Enterprise Resource System: Systems, Lifecycle, Electronic Commerce, Daniel E O'Leary, Cambrige University Press, 2000.
4. Enterprise Resource Planning, Mary Sumner,"Pearson,2007

CS-6328 DECISION SUPPORT SYSTEMS CR-3

Introduction: Concepts of Data, Information, Information Systems & End Users. Systems Concepts: Open System, Closed System; Information Systems and Systems Concept. Building Information System: System Analysis and Design - Systems Development Cycle (Identification of Requirements, Feasibility Study, System Analysis, Design and Implementation), Prototyping Evolution of Information Systems: TPS, OAS, MIS, DSS, EIS, ES **8Hrs**

Decision Making: Introduction and Definitions, Simons Decision Making Model, How Decisions are Supported, DSS Configurations, DSS Characteristics and Capabilities, Components of DSS, DSS Classifications DSS Modeling-Static and Dynamic Models, Certainty, Uncertainty, and Risk, Sensitivity Analysis, What-IF, and Goal Seeking, Making Decisions in Groups: Group Decision Support System(GDSS),Characteristics, Process, Benefits, and Dysfunctions, Supporting Group work with Computerized Systems, Tools for Indirect and Indirect Support of Decision Making, From GDSS to GSS. **10Hrs**

Knowledge Management System: Definition and types of Knowledge, Frame work for Knowledge Management, Knowledge Representation Techniques: Rules, Frames, Semantic Networks, Introduction to Business Intelligence: Origins and Drivers of Business Intelligence, General Process of Intelligence Creation and Use, Characteristics of Business Intelligence, Towards Competitive Intelligence, Successful BI Implementation, Structure and Components of BI, Future trends. **10Hrs**

Business Analytics: Online Analytical Processing (OLAP), Reporting and Queries, Multidimensionality, Knowledge Discovery in Databases(KDD), framework of KDD. Data Mining Concepts and Applications, Framework of data mining, Text Mining, Web Mining Usage, Benefits, and Success of Business Analytics **8Hrs**

Text Books:

1. Decision Support & Business Intelligent Systems, Turban, Efrain, Pearson Education, 2007.

Reference Books:

1. Decision Support Systems in the 21st century, Marakas, George.M., Pearson Education, 2003.
2. Managing A Digital Firm, Laudon, Pearson Publishing, 2002.

CS-6332 GEOSPATIAL DATA MANAGEMENT CR-3

Introduction: Introduction, Definitions of GIS and related terminology, The Evaluation of GIS, Components of GIS, Geospatial data, Spatial data infrastructure. Map language: Introduction, Map as a model, Spatial elements and terminology, Classification of maps, Map scale, Spatial referencing system, Computers in map production, Trends in computer construction, General software's in map production. **6 Hrs**

Fundamentals of GIS: A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow, Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, Levels of measurement. **4 Hrs**

Spatial Data Modeling: Introduction; Stages of GIS data modeling; Graphic representation of Spatial Data, Raster data representation, Vector data representation, Spatial data models; Raster GIS models: Types of raster GIS models, Compact raster data models; Vector GIS models, Spaghetti model, Topological model, Shape file, Compact vector data models; Comparison of Raster and Vector Models. **6 Hrs**

GIS Data Management: Introduction, Database management systems: Functions of DBMS, Components of DBMS; GIS data file management: Simple list, Ordered sequential files, Indexed files, Building GIS worlds; Database models: Hierarchical database models, Network systems, Relational database models, Standard query language (SQL), Storage of GIS data, The hybrid data model, The integrated data model; Object based data models: Entity-Relationship-Attribute model, Organizational strategy of DBMS in GIS. **8 Hrs**

Data Input, Editing & Quality: Introduction, The data stream, Data input methods: Keyboard entry, Manual digitizing, Scanning and automatic digitizing; GPS for GIS data capture, Data editing, Detecting and correcting errors, Data reduction and generalization, Edge matching and Rubbersheeting. Components of data quality. Accuracy, Precision and resolution, Consistency, Completeness, Sources of error in GIS; Modeling errors, Point data error models, Line and area data error models, Models for dot and pixel counting; Error evaluation by graphical methods. **8Hrs**

GIS Applications:

Remote sensing and GIS Linkage, GIS softwares, Case studies **4Hrs**

Text Books:

1. Geographical Information Systems by Demmeers, M.N. WILEY, 2009

References Books :

1. Manual of Geospatial Science and Technology Edited By John. D. Bossler, Taylor And Francis, London, 2005
2. Text book of Remote sensing and GIS by M. Anji Reddy, BSP Publications, Hyderabad., 2006

CS-6334 BUSINESS ANALYTICS AND INTELLIGENCE CR-3

Business Analytics:

Overview of business analytics - Examples of BA Applications – Business analytics at the strategic level - link between strategy and deployment of BA – four scenarios on strategy and BA - Common database marketing application obstacles to implementing database marketing application-two definition on data mining-classes of data mining methods. **6 Hrs**

Business Analytics in Data Warehouse and Mining:

Business analytics at the data warehousing level - why a data warehouse - architects and processes in the data warehouse - business analytics in future - data visualization - Business analytics and data mining - two definition on data mining - classes of data mining methods -grouping method - predictive modeling method – Crisp - dm phase - process model within a phase-business understanding-data understanding. **8 Hrs**

Business Analytics useness Intelligence:

Defining business intelligence - need for business intelligence - building a road map - designing and planning business intelligence process - From raw data to marketing information - Customer and transactional file - Internal and external data sources (data enhancements and overlays). **6 Hrs**

Business Intelligence Database and Data Warehouse:

Data warehousing, legacy system, data marts and marketing databases - Relational databases and models- Structured query language (SQL) – end-user perspective -Data mining for business intelligence- Online transaction processing (OLTP)- Online analytical processing (OLAP- Data warehouses and data marts. **8 Hrs**

Data Storage and Retrieval:

Querying data from data servers (SQL)- Restructuring transactional files - Recoding alphanumeric and date variables- Date transformation into time periods- Data Import and Transformation- Linear Regression- Regression Output- Regression Transformation- Logistic Regression- Logistic Regression Output. **8 Hrs**

Text Books:

1. *Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner*, Shmueli, Patel and Bruce Wiley publication,2nd Edition 2010.

Reference Books:

1. *Customer and Business Analytics:Applied Data mining for business decision making using R*, Daniel S. Putler, Robert E. Krider, CRC press,edition 2012.
2. *Business Analytics for Managers:Taking Business Intelligence Beyond Reporting",* Gert H. N. Laursen, Jesper Thorlund, 2nd edition, 2010.
3. *Business Intelligence: A ManagerialApproach,* P Turban, Sharda, Delen, King,Prentice Hall,: ,Prentice Hall , 2nd Edition ,2010.
4. *Data Mining for Business Intelligence: Concepts, Techniques, and Applications in Microsoft OfficeExcel with XLMiner*, Galit Shmueli, Nitin R. Patel and Peter C Wiley, 2007.
5. *Data Warehousing Fundamentals - A comprehensive guide for IT professionals*", Paulraj Ponniah, , John Wiley publications, 2nd Edition , 2010.

CS-6336 GRAPH THEORY & APPLICATIONS CR-3

Introduction: Definitions, importance, isomorphism, walk, paths, circuits, connected, disconnected graphs, operation on graphs operation on graphs, Euler and Hamiltonian graphs. **5Hrs**

Trees: Properties, distance and centers, trees, spanning trees, fundamental circuits, minimal spanning tree. **5Hrs**

Cut Sets and cut vertices: Properties, fundamental circuits and cut sets, connectivity, separatability, network flows, 1-2isomorphism. **5Hrs**

Planar and Dual Graphs: Combinatorial representation, planar graphs, kuratowski's graphs, detection of planarity, dual graphs. **5Hrs**

Matrix Representation of Graphs: Incidence matrix, circuit matrix, cut set matrix, fundamental matrices, relationships amongst matrices, path matrix, and adjacency matrix. **4Hrs**

Coloring, Covering and Partitioning: Chromatic number, chromatic partitioning, matching, covering, four color problem. **4Hrs**

Directed Graphs: Different types, directed paths and connectedness, Euler digraphs, trees-matrix representation, ournament. **4Hrs**

Graph Theoretic Algorithms: Computer representation of graphs - input & output, algorithms for connectedness, spanning tree, fundamental circuits, cut vertices, directed circuits and shortest paths. **3Hrs**

Text Books:

1. Graph Theory with Application to Engineering and Computer Science ,N. Deo, PHI, . 1995.

References Books:

1. Graph Theory with Applications, J.A. Bondy and U.S.R. Murty, 2nd Edition, North Holland, 2008.
2. 3., Introduction to Graph Theory, Douglas West,2nd Edition, Prentice Hall, 2000.
3. Discrete Mathematics, C L Liu and D P Mahapatra ,3rd Edition ,TMH, 2008
4. Graph, Networks and Algorithms, Tulasiraman and M.N.S. Swamy, John Wiley,1981.
5. 6.Graph Theory, F. Harary, Addison Wesley, 1998.

SCHOOL OF COMPUTER ENGINEERING

SPECIALIZATION: SOFTWARE ENGINEERING

CS-6401 SOFTWARE REQUIREMENTS ENGINEERING CR-4

Introduction **4 hrs**

FAQs about requirements, Systems engineering

Requirements Analysis & Specification **8 hrs**

Requirements Gathering and Analysis, SRS, Formal Specification, Axiomatic Specification, Algebraic Specification, Z-Specification

Requirements Engineering Processes **5 hrs**

Process Models, Actors in requirements engineering processes, Process support, Process improvement

Requirements Elicitation and Analysis **6 hrs**

Elicitation and analysis processes, Elicitation techniques, Prototyping, Requirements analysis and negotiation

Requirements Validation **5 hrs**

Requirements reviews, Prototyping, Model validation, Requirements testing.

Requirements Management **5 hrs**

Stable and volatile requirements, Requirements identification and storage, Change management, Traceability

Methods for Requirements Engineering **4 hrs**

Data-flow modeling, Semantic data models, Object-oriented approaches, Formal methods.

Viewpoint-oriented Requirements Methods **5 hrs**

Structured Analysis and Design Technique, Controlled Requirements Expression (CORE), Viewpoint-Oriented System Engineering, Viewpoint-oriented Requirements Definition, Viewpoints-oriented requirements validation

Non-functional Requirements **6 hrs**

Classification of non-functional requirements, Deriving non-functional requirements, Requirements for critical systems, Requirements engineering for safety-related systems.

Text Books:

1. G. Kotonya and Ian Sommerville, *Requirements Engineering: Processes and Techniques*, John Wiley & Sons, 2002

Reference Books:

1. Rajib Mall, *Fundamentals of Software Engineering*, PHI Third edition, 2011
2. Klaus Pohl, *Requirements Engineering: Fundamentals, Principles & Techniques,* Springer International Edition, 2010
3. Elizabeth Hull, Ken Jackson and Jeremy Dick, *Requirements Engineering*, Springer, 2011
4. Ian Sommerville, Pete Sawyer., *Requirements Engineering: A Good Practice Guide*, Wiley India, Wiley Students Edition, Reprint, 2011
5. Brian Berenbach, Daniel J. Paulish, JuergenKazmeier, Arnold Rudorfer, *Software & Systems Requirement Engineering In Practice,* TMGH, 3rd Reprint, 2010
6. R.S. Pressman, *Software Engineering,* MGH, 7th Edition, 2010

CS-6402 **SOFTWARE TESTING** **CR-4**

Introduction **7 hrs**

Introduction to software testing, software testing terminology and methodology, verification and validation, evolution of testing, software testing life cycle, V-model for software testing, testing and debugging, levels of testing, software defect management, flow graphs, code-based testing, logic based testing, configuration management, risk analysis, model based testing, statistical testing, formal testing.

Testing Techniques:

Dynamic testing: white-box testing techniques **3 hrs**

Static testing **3 hrs**

Slice based testing, mutation testing, coverage analysis, defect seeding

Regression testing **4 hrs**

Regression test process, test case selection, test case prioritization, code based and model based regression testing.

Testing Process:

Test planning **6 hrs**

Test policy, test strategy, quality plan and test plan, test estimation, test scenario, test scripts, test log document, generation of test data, test progress monitoring,

Test metrics and test reports **8 hrs**

Testing data, categories of product test metrics, resource consumed in testing, defect density, test reports, project test status reports, integration, system and acceptance test report, test process improvement, benchmarking.

Testing Strategies:

Integration and System Testing **6 hrs**

Top down and bottom up integration, bi-directional integration, system integration, scenario testing, defect bash, functional versus non-functional testing, design/architecture verification, deployment testing, scalability testing, reliability testing, stress testing

Acceptance Testing: **4 hrs**

Acceptance testing criteria, alpha, beta and gamma testing , acceptance testing during each phase of SDLC, criticality of requirements, software acceptance plan, user's responsibility.

Test Management and Automation: **6 hrs**

Software test automation,scope of automation, design & architecture for automation, FSM based testing; generic requirements for test tool framework, testing tools selection, testing in object oriented systems, testing web-based systems

Current Research and Emerging Trends in software testing **1 hr**

Text Books:

1. S. Desikan and G. Ramesh, "Software Testing: Principles and Practices", Pearson Education, Sixth Impression, 2008.

Reference Books:

1. M.G.Limaye, " Principles, Techniques and Tools", MGH, 6th Reprint 2012
2. NareshChauhan,"Software Testing Principle and Practices", 2nd Impression, Oxford University Press, 2011
3. Aditya P. Mathur, "Foundation of Software Testing", Pearson Education, 2007
4. SagarNaik, PiyuTripathy, "Software Testing and Quality Assurance: Theory and Practice", Wiley, 2011
5. Yogesh Singh, "Software Testing", 1st edition, Cambridge University Press, 2012
6. R.V. Binder, "Testing Object-Oriented Systems", Addison-Wesley, 1999
7. Paul Ammann and Jeff Offutt, "Introduction to Software Testing", Cambridge University Press, 2008

CS-6421 SOFTWARE DESIGN PATTERN CR-3

Software Design **5 hrs**

Design Paradigms, Various Design Approaches, Coupling and Cohesion, Functional Independence, Characteristics of a Bad Design, Design process

Object Oriented Design **4 hrs**

Design with objects, OOD process, OOD goodness criteria, OOD using UML, OOD vs. FOD

Design Principles **6 hrs**

Open & Close Principle, Dependency Inversion Principle, Interface Segregation Principle, Single Responsibility Principle, Liskov's Substitution Principle

Imparting Design Knowledge **2 hrs**

Describing a design solution, Transferring design knowledge, Design representation: black box and white box notation

Design Practices **8 hrs**

Stepwise refinement, Incremental design, Structured systems analysis and structured design, Jackson structured programming (JSP), Jackson system development (JSD), Component-Based design

GRASP Patterns **4 hrs**

Information Expert, Creator, Controller, Low Coupling, High Cohesion, Polymorphism, Pure Fabrication, Indirection, Protected Variations

Design Patterns **7 hrs**

Introduction to design patterns and GoF, *Creational Patterns*:Singleton, Factory, Factory Method, Abstract Factory, Builder, Prototype,Object Pool, *Behavioral Patterns:* Chain of Responsibility, Command, Interpreter, Iterator, Mediator, Memento, Observer, State, Strategy, Template Method, Visitor, Null Object, *Structural Patterns:* Adapter, Bridge, Composite, Decorator, Flyweight, Facade, Proxy, Identification of appropriate design patterns from SRS

Text Books:

1. David Budgen, Software Design, Pearson, Second Edition, 2013

Reference Books:

1. Eric Braude, Software Design: From Programming to Architecture, Wiley, 1st Edition, 2006
2. Eric Gamma, Richard Helm, Ralph Johnson, John Vlissides, "Design Patterns: Elements of Reusable Object-Oriented Software", Pearson, 1st Edition, 2002.
3. Craig Larman, "Applying UML &Patterns: An Introduction to Object-Oriented Analysis and Design", Prentice Hall PTR, 1997.
4. Wolfgang Pree, *"*Design Patterns for Object-Oriented Software Development*",* Addison-Wesley, 1st Edition, 1994
5. Steven John Metsker, William C. Wake, "Design Patterns in Java", Addison-Wesley Professional, 2008

CS-6422 SOFTWARE PROJECT MANAGEMENT CR-3

Introduction to Software Project Management **2 hrs**

Overview of project, project management, Project management process, Activities of project management, setting objectives, plans, methods and methodologies, setting objectives, project success and failures

SW Project life cycle **3 hrs**

Concept, analysis, planning, execution and closing stage, The ISO 12207 Software development life cycle, Project selection **m**ethodologies and technologies, process models, selection of appropriate process model

SW Project evaluation & Planning **5 hrs**

Tools and techniques, funds flow analysis, cost-benefit analysis, risk evaluation, project portfolio management, benefit management, Gathering requirements, Identification of project scope, step wise project planning, case study

Software project estimation **2 hrs**

Software effort estimation techniques, cost estimation, effect of schedule compression, Capers Jone's estimation

Design of software project management system **5 hrs**

Activity planning, Work breakdown structures, product breakdown structure, resource break-down structure, project scheduling, activity on arrow, activity on node, dummy activities, Use of Gantt chart, formulating a network (CPM), activity float, and critical activity

Risk management **4 hrs**

Risk identification, assessment, planning, and management, evaluating risks to schedule, application of PERT

Project Cost Analysis **3 hrs**

Resource Allocation, schedule resources, crashing and resource sharing, network scheduling with Limited Resources, capacity planning and capacity expansion decision

Software project monitoring and control **3 hrs**

Design of monitoring system, prioritizing monitoring, Progress control, performance control, schedule control, cost control tools used in controlling project, earned value analysis, change control, status review meeting, project audit and reviews

Managing contracts **2 hrs**

Types of contracts, contract placements, contract management

Software Project organizations & Managing people in software environment **4 hrs**

Functional, matrix and projectized organization, various team structures, Organization behavior, coordination and procedures, project management and procedure, working in teams, skills and competency of the manager

Scope and software quality control **3 hrs**

Importance of software quality, SQC, SQA, product process and quality, cost of quality, ISO 9126, Process capability models, quality management system, software testing and reliability.

Text Books:

1. Bob Hughes, Mike Cotterell, Rajib Mall, *Software Project Management*, McGraw-HILL, 2011, 5th Edition

Reference Books:

1. R. Walker, *Software Project Management*, Pearson, 2003
2. Jerome D. Wiest, Ferdinand K. Levy, *A Management Guide to PERT/CPM,* PHI, 2nd Edition, 2008
3. Robert K. Wysocki, *Effective Software Project Management*, Wiley India, Edition, 2008

CS-6423 **SOFTWARE ARCHITECTURE** **CR-3**

Introduction **2 hrs**

Architecture - Engineering Discipline for Software, Architecture Business Cycle, Software Processes. Features of Good Architecture

Architecture Styles **6 hrs**

Pipes and Filters, Data Abstraction and Object Oriented organization, Even-based Implicit Invocation, Layered Systems, Registers, Interpreters, Process Control, Other Familiar Architectures, Heterogeneous Architectures

Shared Information Systems **5 hrs**

Database Integration, Interpretation in Software Development Environments, Architectural Structures for Shared Information Systems

Architectural Design Guidance **5 hrs**

Guidance for User Interface Architectures, Case Study in Inter Operability: World Wide Web.

Architectural Patterns **6 hrs**

Pattern Types, Structural Patterns, Patterns for Distribution, Patterns for Interactive Systems

Formal Models And Specifications **4 hrs**

Finalizing the Architecture of a Specific System. Architectural Style, Architectural Design Space, Case Study of an Industry Standard Computing Infrastructure: CORBA

Architectural Description Languages **4 hrs**

ADL today, capturing Architectural Information in an ADL, Application of ADL in system Development, Choosing an ADL

Architecture Reuse **3 hrs**

Reusing Architectural Assets within an Organization, Creating Products and Evaluating a Product Line, Organizational Implications of a Product Line, Component Based Systems,

Current Trends in Software Architecture **1 hr**

Text Books:

1. Mary Shaw, David Garlan, “Software Architecture: Perspectives on an Emerging Discipline”, PHI Learning, 1st Edition, 2009

Reference Books:

1. Rick Kazman, Len Bass, Paul Clements, “Software Architecture in Practice”, Pearson, 2nd Edition, 2011.
2. Frank Buschmann, RegineMeunier, Hans Rohnert, Peter Sommerlad, Michael Stal, Pattern-Oriented Software Architecture, Wiley, 1st Edition, 2008
3. Garmus, Herros, “Measuring the Software Process: A Practical Guide to Functional Measure”, 1996, PHI.
4. Florac, Carleton, “Meas. Software Process: Stat. Proce. Cont. for Software process Improvemnts”, 1999, PEA.
5. W.Humphery, “Introduction to Team Software Process”, 2002, PEA.
6. Peters, “Software Design: Methods and Techniques”, 1981, Yourdon.
7. Buschmann, “Pattern Oriented Software Architecture”, 1996, Wiley.
8. Gamma et al, “Design Patterns”, 1995, PEA.
9. Gamma, Shaw, “An Introduction to Software Architecture”, 1995, World Scientific.
10. Shaw, Gamma, “Software Architecture”, 1996, PHI.

CS-6424 SOFTWARE ENGINEERING PROCESS & QUALITY CR-3

Software Engineering Process:

Process Implementation and Change **4 hrs**

Process infrastructure: software engineering process group, experience factory; Activities; Models for process implementation and change; Practical Consideration;

Process Definition **10 hrs**

Perspective Models, The Waterfall Model, Incremental Process Model, Evolutionary Process Models, Specialized Process Models: Component-based development, Formal Methods Model, Aspect-Oriented Software Development; The Unified Processes, Timebox Model, Agile Process Models: Extreme Programming, Adaptive Software Development (ASD), Dynamic Software Development Methods (DSDM), Scrum, Crystals, Feature Driven Development (FDD), Agile Modeling (AM); Process Adoption; Automation

Process Assessment **1 hr**

Process assessment models; Process assessment methods

Product & Process Measurement **3 hrs**

Software process measurement; Software product measurement: size measurement, structure measurement, Measurement Techniques: analytical techniques, Benchmark techniques

Software Quality:

Software Quality Fundamentals **8 hrs**

Concepts of S/W Quality: quality views from different perspectives and stakeholders, core components of the quality of a product, quality gap, Total Quality Management, Six Sigma Quality, quality control, quality assurance and quality management. Value & cost of quality; Quality models and characteristics: software process quality, software product quality; Quality Improvement; Application quality requirements: criticality of systems, dependability, Integrity levels of software; Defect characteristics

Software Quality Management Processes **6 hrs**

Software quality assurance (SQA), SQA Activities, Software Reviews, Formal Technical Reviews, Formal Approaches to SQA, Statistical Software Quality Assurance: Six sigma for software engineering, The ISO 9000 Quality Standards,PSP, SPICE, The SQA Plan. Software quality management techniques: Static techniques, people intensive techniques, analytic techniques, dynamic techniques; Software quality measurement;

Software Quality Control Practices **4 hrs**

Software Verification & Validation (V&V): Definition of V&V: system V&V and software V&V, independent V&V; V&V Techniques: testing, demonstration, traceability, analysis, inspection, peer review, walkthrough, Audit

Text Books:

1. Roger S Pressman, Software Engineering-A Practitioner's Approach, TATA McGRAW-HILL, 6th Edition, 2010

Reference Books:

1. M. Limaye, Software Quality Assurance, 1st Edition, Tata Mcgraw Hill Education Private Limited, 2011.
2. Authored by IEEE Computer Society, Guide to the Software Engineering Body of Knowledge, Software Engineering Body of Knowledge (SWEBOK), Edited by Alain Abran, James W. Moore, Pierre Bourque, Robert Dupuis, 2004

CS-6426 SOFTWARE RELIABILITY CR-3

Introduction **5 hrs**

Defining Software Reliability, Software Reliability Attributes and Specification, Concept of Defects, Faults, Failures, Defect Rate and Reliability, Defect Prevention, Reduction, and Containment, Overview of Different Types of Software Review, Introduction to Measurement and Inspection Process, Documents and Metrics.

Software Reliability Metrics **7 hrs**

Collection of fault and failure data, Measurement of internal and external product attributes, Customer Problems Metric, Customer Satisfaction Metrics, In-Process Quality Metrics: Defect Arrival Pattern, Phase-Based Defect Removal Pattern, Defect Removal Effectiveness, Metrics for Software Maintenance, Software Reliability indicators, Software Reliability Metrics, Static Code Metrics, Dynamic Metrics.

Software Reliability Assessment Models **6 hrs**

Basics of Reliability Theory, Software Reliability Problem, Modeling Process, Software Reliability Models, Parametric Reliability Growth Models, The Rayleigh Model, Exponential Distribution and Software Reliability Growth Models, Software Quality Assessment Models: Hierarchical Model of Software Quality Assessment.

Software Reliability Allocation Models **5 hrs**

Software Reliability Allocation Models, Criteria for Model Evaluation, Optimal ReliabilityAllocation, Quality Planning and Control, Quality Improvement Process, Evolution of Software Quality Assurance (SQA), Major SQA Activities, Major SQA Issues, Zero Defect Software.

Reliable Software Design **7 hrs**

Basic design principle of reliable software, requirements, objectives, and specifications, system architecture, program structure design, design practices, module design and coding, programming style. Software testing principles, module testing, functions and system testing, debugging, programming languages and reliability, computer architecture and reliability, proving program correctness, software support systems

Software Reliability Techniques **6 hrs**

Reliability Techniques: Trending Reliability Techniques, Predicting Reliability Techniques, Error Seeding, Failure Rate, Curve Fitting, Operational Profile, Reliability Growth Models and Tools: Study of tools like CASRE, SARA, SMERFS.

Text Books:

1. John D. Musa, Software Reliability Engineering: More Reliable Software Faster and Cheaper, Tata Mcgraw Hill Education Private Limited, 2nd Edition, 2005.

Reference Books:

1. Hoang Pham, “Software Reliability”, Springer, 2000
2. Min Xie, “Software reliability modeling”, World Scientific, 1991
3. M.L Shooman, “Software Engineering: Design, Reliability and Management”, Mcgraw Hill, 1983.
4. Fenton, and Pfleeger, “Software Metrics: A Rigorous and Practical Approach”, International Thomson Computer Press, 2nd Revised Edition, 1998.
5. Michael R Lyu, “Handbook of Software Reliability Engineering”, IEEE Computer Society Press, 1996.
6. Charles Ebeling, “An Introduction to Reliability and Maintainability Engineering”, Mcgraw Hill, 2004.
7. Elsayed A. Elsayed, “Reliability Engineering”, Wiley, 2012.
8. Stephen H. Kan, “Metrics and Models in Software Quality Engineering”, Addison-Wesley, 2002.

CS-6428 SW MAINTENANCE & CONFIGURATION MANAGEMENT CR-3

Software Maintenance:

Software Maintenance in a context **3 hrs**

Nature of software maintenance, Software Maintenance Types, Characteristics of Maintainable Software, Lehman's laws

Maintenance cost **3 hrs**

Maintenance cost issues using COCOMO model, Maintainability Measurements and Maintenance Cost Factors.

The software maintenance process **4 hrs**

Change requests management, Version and Release management issues, Version and Release management issues, Legacy Systems Structure and definitions, Legacy System Design, Legacy replacement strategies, Legacy System Assessment.

System Evolution **3 hrs**

Program Evolution Dynamics, Architectural Evolution (n-tire), Architectural Evolution (VMC, SC, Web services)

Software Re-engineering **3 hrs**

The re- engineering Process definition, Reverse Engineering Vs forward engineering, Re-engineering process structure, Software Reusability Definition, Software Reuse and Maintainability Issues, Reusable Components

Design Patterns and Maintainability Issues **3 hrs**

Design patterns and effects on software maintainability, A look at some design patterns under use, Open-source and maintainability issues, Frameworks and maintainability issues.

Software Configuration Management:

Management of the SCM Process **6 hrs**

Organizational Context for SCM; Constraints and Guidance for the SCM Process; Planning for SCM: SCM organization and responsibilities, SCM resources and schedules, Tool selection and implementation, Vendor/Subcontractor Control, Interface control; SCM Plan; Surveillance of Software Configuration Management: SCM measures and measurement, In-process audits of SCM.

Software Configuration Identification **3 hrs**

Identifying Items to Be Controlled: Software configuration item, Software configuration item relationships, Software version, Baseline, Acquiring software configuration items; Software Library

Software Configuration Control **5 hrs**

Requesting, Evaluating, and Approving Software Changes: Software Configuration Control Board, Software change request process; Implementing Software Changes; Deviations and Waivers.

Software Configuration Status Accounting **1 hr**

Software Configuration Status Reporting.

Software Release Management and Delivery **2 hrs**

Software Building, Software Release Management

Text Books:

1. Grubb P., Takang A A., Software Maintenance- Concepts and Practice, 2nd Edition, World Scientific, 2007
2. Gopalaswamy Ramesh, Ramesh Bhattiprolu, Software Maintenance, Tata Mcgraw Hill Education Private Limited, 2005, 1st edition.

Reference Books:

1. Authored by IEEE Computer Society, Guide to the Software Engineering Body of Knowledge, Software Engineering Body of Knowledge (SWEBOK), Edited by Alain Abran, James W. Moore, Pierre Bourque, Robert Dupuis, 2004
2. Bersoff E.H., V.D.Hendersom, S.G. Siegel, Software Configuration Management, Englewood Cliffs, N.J., Prentice- Hall 1980.
3. Babich, W. A., Software Configuration Management, Addision-Wisley, 2006.
4. Gunther, R.C., Management Technology for software product engineering, New York, John Wiley, 2005.
5. SommervilleIan,Software Engineering, Addison Wesley, 2008

CS-6432 SOFTWARE METRICS CR-3

Introduction to software cost estimation **6 hrs**

Software Estimation Approaches, Origins of software cost estimation, Forms of software cost estimation, Factors that influence productivity, software cost estimation tools and project success and failure rates, Sources of errors in software cost estimation.

Software Size Estimation **7 hrs**

Lines of Code; Language Productivity Factor; Counting Reused and Refactored Code; Counting Non-Procedural Code Length; Measuring the Length of Specifications and Design, Function Points, Converting Function Points to Physical Size; Converting Function Points to Effort; Other Function Point Engineering Rules; Function Point Pros and Cons; Feature Points

Software Complexity Estimation **7 hrs**

Structural Complexity: Size as a Complexity Measure: System Size and Complexity, Module Size and Complexity; Cyclomatic Complexity; Halstead's Metrics; Information Flow Metrics; System Complexity; Maintainability Index; Object-Oriented Design Metrics

Conceptual Complexity, Computational Complexity

Software Effort Estimation **10 hrs**

Software Estimation Methodologies and Models; Expert Estimation: Work and Activity Decomposition, System Decomposition, The Delphi Methods; Using Benchmark Size Data; Estimation by Analogy; Traditional Analogy Approach; Analogy Summary; Proxy Point Estimation Methods; Meta-Model for Effort Estimation; Function Points; COSMIC Function Points; Object Points; Use Case Sizing Methodologies; Use Case Points Methodology; Custom Models; Algorithmic Models; Manual Models; Estimating Project Duration; Tool Based Models; Combining Estimates; Estimating Issues; Targets vs. Estimates; The Limitations of Estimation; Estimate Uncertainties; Estimating Early and Often.

Activity-Based Software Cost estimation **6 hrs**

Specialized estimation techniques: Estimation of Agile Development, Estimation of Web engineering projects, Estimating Software Requirements; Estimating Software Prototypes, Estimating Software Specifications and Design, Estimating Design Inspections, Estimating Programming or Coding, Estimating Code Inspections, Current trends in software cost estimation

Text Books:

1. Capers Jones, Estimating Software Costs, Tata McGraw Hill Education Private Limited, 2nd Edition, 2007.
2. Linda M. Laird, M. Carol Brennan, Software Measurement and Estimation: A Practical Approach, Wiley-IEEE Computer Society Press, June 2006

Reference Books:

1. Peter Hill, Practical Software Project Estimation, Tata McGraw Hill Education Private Limited, 1st Edition, 2011
2. Steve McConnell, Software Estimation: Demystifying the Black Art, Microsoft Press, 2006
3. M. A. Parthasarathy, Practical Software Estimation: Function Point Methods For Insourced and Outsourced Projects, Pearson, 1st Edition., 2007

SCHOOL OF ELECTRICAL ENGINEERING

SPECIALISATION: POWER AND ENERGY SYSTEM

EE 6101 POWER SYSTEM DYNAMICS Cr-4

Synchronous Machines:
The basics of general theory, general equations of AC machines, Park's transformation, derivations of two axis equation and simplified equation of synchronous machine with two damper winding, equivalent circuits, operational impedances. **8 Hrs**

Synchronous generator short circuits and system faults:
Constant flux linkage theorem, its application to three phase alternator: sudden three phase short circuit on a three phase unloaded alternator, analysis of short circuit oscillogram, system fault calculation, short circuit of a loaded alternator, line to line short circuit, equivalent circuit under transient condition, simplified phasor diagram for transient condition. **10 Hrs**

Transient stability:
Swing equation and its solution by Numerical methods: The equal area criteria for stability. Applicability of equal area criteria, one machine swing with respect to infinite bus, two finite machines. Introduction to second method of Lyapunov for study of transient stability of power system with special reference to single machine connected to infinite bus including VAR and governor action. **10 Hrs**

Dynamic stability:
State space model of synchronous machine and excitation systems. Linear models, Improved models, modeling of turbines and their governors. Load characteristics Dynamic stability. Effect of excitation switch. Analysis of Inter connected switch. **10 Hrs**

Methods of Improving Stability:
Transient stability enhancement; High Speed Fault Clearing, Dynamic Breaking, Load shedding, Control of HVDC Transmission Links. Small signal Stability Enhancement; Power system stabilizers, control of static VAR compensators. **10 Hrs**

Text Books:

1. Power System Stability Control: P.Kundur,Mc Grawhill, New Tork, 1994.
2. Generalized Theory of Alternating Current Machines – B. Adikin's & R.G. Harley Chapman & Hall, 1959.2nd edition

Reference Books:

1. Power system Dynamics – B.R.Gupta, S.Chand Publishers, Reprint 2013.
2. Power System Stability: E.W.Kimbark. Vol -I,II,III., Willy (India) latest Edition.
3. Generalized Theory of Electrical Machines- By P.S.Bimbhra, 4th Edition.

EE 6102 POWER SYSTEM RESTRUCTURING Cr-4

Power Sector in India
Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act. **8 Hrs**

Power sector economics and regulation
Typical cost components and cost structure of the power sector, Different methods of comparing investment options, Concept of life cycle cost , annual rate of return , methods of calculations of Internal Rate of Return(IRR) and Net Present Value(NPV) of project, Short term and long term marginal costs, Different financing options for the power sector . Different stakeholders in the power sector, Role of regulation and evolution of regulatory commission in India, types and methods of economic regulation, regulatory process in India. **8 Hrs**

Power Tariff
Different tariff principles (marginal cost, cost to serve, average cost), Consumer tariff structures and considerations, different consumer categories, telescopic tariff, fixed and variable charges, time of day, interruptible tariff, different tariff

based penalties and incentives etc., Subsidy and cross subsidy, life line tariff, Comparison of different tariff structures for different load patterns. Government policies in force from time to time. Effect of renewable energy and captive power generation on tariff. Determination of tariff for renewable energy. **8 Hrs**

Power sector restructuring and market reform

Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments. Different market and trading models / arrangements, open access, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power. **8 Hrs**

Electricity Markets Pricing and Non-price issues

Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices. Non price issues in electricity restructuring (quality of supply and service, standards of performance by utility, environmental and social considerations) Global experience with electricity reforms in different countries. **8 Hrs**

Transmission Planning and pricing

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right. Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction.Power purchase agreements. **8 Hrs**

Text Books:

1. Kankar Bhattacharya, Math H.J. Boller, Jaap E.Daalder, 'Operation of Restructured Power System' Klumer Academic Publisher, 2010.
2. Mohammad Shahidehpour, and Muwaffaq alomoush, - "Restructured electrical Power systems" Marcel Dekker, Inc.

Reference Books:

1. Loi Lei Lai; "Power system Restructuring and Deregulation", Jhon Wiley & Sons Ltd., England.
2. *"Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group,Pune*
3. *Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc.*
4. *Electric Utility Planning and Regulation, Edward Kahn, American Council for Energy Efficient Economy.*

EE 6103 ADVANCED RENEWABLE ENERGY SYSTEMS Cr-3

Solar Energy:

The Sun – Production and transfer of solar energy – Sun-Earth angles – Availability and limitations of solar energy – Measuring techniques and estimation of solar radiation – Solar thermal collectors – General description and characteristics – Flat plate collectors – Heat transfer processes – Short term and long term collector performance – Solar concentrators – Design, analysis and performance evaluation of solar energy technologies. **6 Hrs**

Wind Energy :

Wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems : System components, Types of Turbine, Turbine rating Choice of generators, turbine rating, electrical load matching, Variable speed operation, maximum power operation, control systems, system design features, stand alone and grid connected operation. **6 Hrs**

Biomass :

Various resources, energy contents, technological advancements, Conversion of biomass in other form of energy - solid, liquid and gases. Gasifiers, Biomass fired boilers, Cofiring, Generation from municipal solid waste, Issues in harnessing these sources. **6 Hrs**

Hydro energy :
Feasibility of small, mini and micro hydel plants scheme layout economics.
Tidal and wave energy, Geothermal and Ocean-thermal energy conversion, (OTEC) systems schemes, feasibility and viability. **6 Hrs**

Energy Storage and hybrid system configurations :
Energy storage : Battery - types, equivalent circuit, performance characteristics, battery design, charging and charge regulators. Battery management. fly wheel energy relations, components, benefits over battery. Fuel Cell energy storage systems. Ultra Capacitors. **6 Hrs**

Grid Integration:
Stand alone systems, Hybrid systems - hybrid with diesel, with fuel cell, solar wind, wind-hydro systems, mode controller, load sharing, system sizing. Hybrid system economics. Grid integration with the system : Interface requirements, Stable operation, Transient-safety, Operating limits of voltage, frequency, stability margin, energy storage, and load scheduling. Effect on power quality - harmonic distortion, voltage transients and sags, voltage flickers. Dynamic reactive power support. Systems stiffness. **6 Hrs**

Text Books:

1. Renewable Energy Resources, Second Edition, John Twidell & Tony Weir, Tailer & Fracis-2008
2. Non-Conventional Energy Resources, B.H. Khan,TMH, 2nd Edition-2009

Reference Books:

1. Wind and Solar Systems by Mukund Patel, CRC Press, 2011.
2. Grid Integration, from: IEEE Journals (Transaction) Willy Black Well.

EE 6104 ELECTRICAL ENERGY SYSTEMS AND MANAGEMENT Cr-4

Overall Structure of Electrical Systems:
Supply and demand side – Economic operation – Input-output curves – Load sharing – Industrial Distribution – Load profiling – Electricity tariff types and calculation – Reactive Power – Power factor – Capacitor sizing – Capacitor losses, location, placement and maintenance. **11 Hrs**

Energy Efficincy:
Energy accounting, monitoring and control – Electricity audit instruments – Energy consumption models – Specific Energy Consumption – ECO assessment and Evaluation methods – Transformer loading/efficiency analysis – Feeder loss evaluation – Lighting – Energy efficient light sources – Domestic/commercial/industrial lighting – Lighting Controls – Luminaries - energy conservation. **11 Hrs**

Energy and Power Policies:

Tariffs and subsidies, Energy utility interface, Private sector participation in power generation, State role and fiscal policy, Energy and development, Role of modeling in energy policy analysis, Energy data base, Data Collection-filtration and analysis, Energy balances, Flow diagrams, Reference energy system, Energy demand analysis, Trend analysis, Optimization techniques, Econometric models, Elasticities approach, Input-output models, Simulation/process models, Energy supply analysis, Costs of exploration and economics of utilization of depletable and renewable resources, Scarcity rent, International energy supply, Energy demand supply balancing, Energy -economy interaction, Energy investment planning, Energy environment interaction, Energy Pricing mechanisms. **20 Hrs**

Electric Loads of Air Conditioning and Refrigeration:
Power consumption in compressors – Electrolytic process – Electric heating – Furnace operation and scheduling – Cogeneration schemes – Optimal operation. **6 Hrs**

Text Books:

1. A.P.W. Thumann: Plant Engineers and Managers Guide to Energy conservation, 7e, UNR, 1977.
2. W.R. Murphy and G. McKay, “Energy management”, Butterworth & Co Publishers, Oxford, UK, 2001.

References:

1. S.C. Tripathy, Electric Energy Utilization and Conservation, Tata McGraw Hill, 1991.
2. W.C. Turner, Energy Management Handbook, 2e, Fairmont press, 2007.
3. UNESCAP- Guide Book on Promotion of Sustainable Energy Consumption, 2002.
4. IEEE Bronze Book: IEEE Standard 739-1984 – Recommended Practice for Energy Conservation and Cost Effective Planning in Industrial Facilities, IEEE Publications, 1996.
5. H. Partab, Art and Science of Utilisation of Electrical Energy, Pritam, 1985., 2nd Edition.

EE 6106 ADVANCED CONTROL SYSTEM Cr-3

1. Cascade Compensation:
Lead, lag and lag lead Compensation, Feedback Compensatin, Robust control design of contunous system, Digital compensator design in z-plane using frequency response. **6 Hrs**

2. State Space Modelling and State feedback design:
State space modelling, state feedback design : Pole placement design using state feedback, design of observer using state feedback, Regulator and servo problem, the separation principle. **9 Hrs**

3. Linear Quadric Optimal Control:
State regulator design through Liapunov equation, Liapunov Matrix equation approach, the matrix Riccati Equation approach. **6 Hrs**

4. Neural Networks for Control:
Artificial Neuron model, Activation function, mathematical model, Network architecture, leaning rules, Training –back propagation. Control with Neural Networks examples. **9 Hrs**

5. Fuzzy control :
Introduction, Fuzzy quantification of knowledge, Fuzzy inference Defuzzification, Designing a Fuzzy logic controller, Application Motor speed control. **6 Hrs**

Text Books:

1. M Gopal- "Digital Control and State Variable Method" , 2nd Ed. Tat Mc Graw Hill
2. Nagrath and Gopal-" Control System Engineering" 4th Ed., New Age International
3. B K Bose- "Modern Power Electronics and AC drives" Pearson (LPE), 16th Edition.

Reference Books:

1. Modern control Engineering by K. Ogata (PHI Publication), 5th Edition.
2. Advanced Control Systems by B.N.Sarkar (PHI Publication)
3. Modern Control Engineering by D. Roy Choudhury (PHI Publication)
4. N. K. Sinha, Control Systems, New Age international, 3rd Edition.

EE 6121 COMPUTER APPLICATION IN POWER SYSTEM Cr-3

Introduction to computer method:

Network matrices, reference frame, network graph, Tree, branch, basic loop and cut sets Basic Incidence matrices Augmented matrices, Primitive networks Network matrices by singular and non singular transformation with Bus frame of reference, Branch frame of reference, Loop frame of reference. **10 Hrs**

Three phase network introduction:

Elements in impedance and admittance form, Balance excitation, Un-balance excitation, Transformation matrices for symmetrical components, Incidence and network matrix for 3-phase elements, Formation of Z bus, Addition of branch, Addition of link problems. **11 Hrs**

Representation of three phase elements in short circuit study:

Short circuit study by balance network by Z bus, LG fault**,** L-L fault**,** 3-ph fault with and without fault impedance**,** problems. **7 Hrs**

Transient stability Analysis:
Load representation**,** Network performance equation, Swing equation, Machine equation, Solution techniques in transient stability study, Modified Euler's method, RK 4th order method, problems. **8 Hrs**

Text Books:
1. Computer Methods in Power System Analysis, Glenn W. Stagg, Ahmed H. El-Abiad, McGraw-Hill Book Company, International Editions,2009.
2. Power System Dynamics and Stability By Jan Machowski, James Richard Bumby Wiley Publications 1997.
3. Computer Application Techniques in Power System, M. A. Pai, 3rd edition, TMH, 2006.

Reference Books:
1. Advanced Power System Analysis and Dynamics, L. P. Singh, New Age International (P) Limited, Publishers, Revised 6th Edition, 2011.
2. Power System Dynamics and Stability by Jan Machowski, James Richard Bumby, Wiley Publications 1997.
3. Power System Analysis by N.V.Ramana, Pearson Publication, 2011

EE 6122 COMPUTATIONAL INTELLIGENT CONTROLLERS Cr-3

Neural Networks and Pattern Association

Differences between biological and artificial neural networks – Typical architecture – Common activation functions – McCulloch – Pitts neuron – Simple neural nets for pattern classification – Linear separability – Hebb net – Perceptron – Adaline – Madaline – Architecture – Algorithm and simple applications – Training algorithms for pattern association – Hebb rule and delta rule – Hetero associative – Auto associative and iterative auto associative net – Bidirectional associative memory – Architecture – Algorithm – Simple applications. **10 Hrs**

Neural Networks Based on Competition

Kohonen self organising maps – Learning vector quantization – Counter propagation – Architecture – Algorithm and applications. **4 Hrs**

Adaptive Resonance And Back propagation Neural Networks

ART1 and ART2 – Basic operation and algorithm – Standard back propagation architecture – Derivation of learning rules – Boltzmann machine learning – Architecture – Algorithm and simple applications **6 Hrs**

Fuzzy Sets And Membership Functions
Properties and operations on classical and fuzzy sets – Crisp and fuzzy relations – Cardinality – properties and operations – Composition – Tolerance and equivalence relations – Simple problems –Features of membership function – Standard forms and boundaries – Fuzzification – Membership value assignments – Fuzzy to crisp conversions – Lambda cuts for fuzzy sets and relations – Defuzzification methods. **10 Hrs**

Applications of Neural Networks and Fuzzy Logic

Applications of neural networks – Pattern recognition – Image compression – Communication – Control systems – Applications of fuzzy logic – Fuzzy pattern recognition – Fuzzy image compression – Fuzzy logic controllers. **6 Hrs**

Text Books:
1. Sivanandam, S.N., Sumathi, S. and Deepa, S.N., "Introduction to Neural Networks Using Matlab 6.0", Tata McGraw-Hill, 2005.
2. Laurene Fausett, "Fundamentals of Neural Networks", Pearson Education, 2004.
3. Timothy Ross, "Fuzzy Logic with Engineering Applications", Wiley, 1998, 16th Edition.

Reference Books:

1. Zimmermann, H.J., "Fuzzy Set Theory and Its Applications", Allied Publishers Ltd, 1999 .
2. Klir G J, Folger T, "Fuzzy Sets, Uncertainty and Information", Prentice Hall of India, 5th Indian reprint, 2002.
3. Zurada, J.M., "Introduction to Artificial Neural Systems", Jaico Publishing House, 2010, 3rd Edition.
4. Mohammad H. Hassoun, "Fundamentals of Neural Networks", Prentice Hall of India, 2003.

EE 6123 POWER MARKET REFORMS Cr-3

Power Sector in India

Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act. **8 Hrs**

Power sector restructuring and market reform

Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments. Different market and trading models / arrangements, open access, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power. **8 Hrs**

Electricity Markets Pricing and Non-price issues

Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices. Non price issues in electricity restructuring (quality of supply and service, standards of performance by utility, environmental and social considerations) Global experience with electricity reforms in different countries. **10 Hrs**

Transmission Planning and pricing

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right. Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction. Power purchase agreements. **10 Hrs**

Text Books:

1. Kankar Bhattacharya, Math H.J. Boller, Jaap E.Daalder, 'Operation of Restructured Power System' Springer Publisher, 2010.
2. Mohammad Shahidehpour, and Muwaffaq alomoush, - "Restructured electrical Power systems" Marcel Dekker, Inc.,2009, CRC press 1st Edition.

Reference Books:

1. Loi Lei Lai; "Power system Restructuring and Deregulation", Jhon Wiley & Sons Ltd., England, 2012.
2. "Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune, 2006.
3. Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc 1st Edition.

EE 6124 HVDC AND FACTS Cr-3

HVDC Transmission

Introduction- comparison of AC and HVDC, HVDC transmission analysis of HVDC converters - pulse number- analysis with and without overlap- converter bridge characteristics- converter. **10 Hrs**

HVDC system control

principles of dc link control- starting and stopping of dc link, power control- harmonics & filters– introduction- generation of harmonics- types of ac filters. power flow analysis in ac/dc systems - general modeling of dc links, solutions of ac- dc power flow. **10 Hrs**

Flexible ac transmission systems(FACTS)

Concept of FACTS - flow of power in an ac system- dynamic stability consideration- basic types of FACTS controllers- static shunt compensators - SVC & STATCOM - objectives of shunt compensation- methods of controllable VAR generation- switching converter type VAR generators-basic operating principle and control approaches- static series compensators - GCSC, TSSC, TCSC & SSSC - objectives of series compensator, variable impedance type series compensators:- basic operating control schemes- power angle characteristics- control range and VA rating- external control- combined compensators. **16 Hrs**

TEXT BOOKS

1. K.R. Padiyar: HVDC Power Transmission System, New Age Intl. Co, 2002.
2. N.G. Hingorani and L.Gyugyi: Understanding FACTS, John willy (Latest Edition) Distributors, New Delhi.

EE 6125 SAFETY AND RELIABILITY OF POWER SYSTEMS Cr-3

Basic Probability Theory:

Review of probability concepts, probability distributions, application of binomial distribution to engineering problems. **10 Hrs**

Network modeling:

System reliability evaluation using probability distributions, frequency and duration techniques. Generation, Transmission and Distribution System. **10 Hrs**

Reliability Evaluation:

Concept of LOLP and E(DNS), evaluation of these indices for isolated systems, reliability analysis using the frequency and duration techniques. **8 Hrs**

Safety

Concept and measures of installations of power apparatus **8 Hrs**

Text Books:

1. George Anders, Alfredo Vaccaro, "Innovations in Power Systems Reliability", Springer,2009.
2. R.N. Allan, Billinton, "Reliability Evaluation of Power Systems" Springer,2010.

Reference Books:

1. Roy Billinton and Ronald Allan Pitam: Reliability Evaluation of Power Systems, Advanced Pub. Program.
2. R.L. Sullivan: Power System Planning, McGraw Hill International Book Co., 1990

EE 6126 ADVANCED POWER SYSTEM PROTECTION Cr-3

Static Relay:

General Introduction to Static Relays, Comparator and Associated Elements, Solid State Power Supply Circuit, Timer Relays and Voltage Relays, Differential Relays, Distance relay and Microprocessor Applications to Protection. **8 Hrs**

Numerical Protection:

Introduction, block diagram of numerical relay, sampling theorem, correlation with a reference wave, least error squared (LES) technique, digital filtering, and numerical over current protection. **8 Hrs**

Digital Protection of Transmission Line:
Introduction, Protection scheme of transmission line, distance relays, traveling wave relays, digital protection scheme based upon fundamental signal, hardware design, software design, digital protection of EHV/UHV transmission line based upon traveling wave phenomenon, new relaying scheme using amplitude comparison. **8 Hrs**

Digital protection of Synchronous Generator:
Introduction, faults in synchronous generator, protection schemes for synchronous generator, digital protection of synchronous generator. **6 Hrs**

Digital Protection of Power Transformer:
Introduction, faults in a transformer, schemes used for transformer protection, digital protection of transformer. **6 Hrs**

Text Books:

1. Digital Protection, L. P. Singh, (New Age International (P) Limited Publishers, New Delhi, 2nd Edition).
2. Digital Relay / Numerical relays – T.S.M. Rao, Tata Mc Graw Hill, New Delhi, 2005.

Reference Books:

1. Power System Protection; Static Relays with Microprocessor Applications, 2nd Edition, T.S.Madhava Rao, Tata Mc Graw Hill, 1989.
2. Transmission Network Protection Paithankar (Marcel & Dekker, New York)
3. Fundamentals of Power System Protection Paithankar & Bhide (Prentice Hall of India Pvt Ltd., New Delhi), 2013.
4. Protective Relaying for Power System II Stanley Horowitz (IEEE press , New York), 1981.

EE 6128 POWER SYSTEM TRANSIENTS Cr-3

Simple Switching Transients:
Circuit closing transients, double frequency transients. **2 Hrs**

Damping:
Generalized damping curves, series R-L-C circuit, resistance switching, load switching, other form of damping. **4 Hrs**

Abnormal Switching Transients:
Normal and abnormal switching, current suppression, capacitance switching, other restrtiking phenomena. Ferro resonance. **4 Hrs**

Transients in 3-phase Circuit:
Impotence of the types of neutral connection, switching a 3-phase reactor with an isolated neutral, 3-phase capacitance switching, the symmetrical components method of solving 3- phase switching transients in star connected transformers, circuit reduction. **6 Hrs**

Transients in D.C Circuits and Conversion Equipments:
Interruption of direct current and periodic functions. Characteristics of thyristor and communication transients. Current limiting static circuit breaker. **4 Hrs**

Topics on Electromagnetic Phenomena:

A review of electromagnetic induction with respect to transients. Attenuatation of static field in to conductors under steady state and transients condition. Electromagnetic shielding. Important of electromagnetic effect for cryogenic systems. **5 Hrs**

Travelling Waves in A Transmission Lines:

circuit with distributed parameters, wave equation, reflection and restriction of travelling waves, behavior of travelling waves at line of termination. Lattice diagram. Attenuation and distortion of travelling waves. Multi conductor system and multi velocity waves. **6 Hrs**

Lighting Phenomena:

Scope of lighting problems, the physical phenomena of lighting, interaction of lighting with power system. Factors contribution to good line design. **5 Hrs**

Text Books

1. Electric Transients in Power Systems by Allan Greenwood, Wiley-Blackwell; 2nd Edition edition,30 May 1991

Reference Books :

2. Transients performance in electric power systems by R. Rudenberg, M.I.T. Press, 1967

E 6131 POWER QUALITY ASSESSMENT & MITIGATION Cr-3

Introduction:

Importance of power quality, terms and definitions of power quality as per IEEE std. 1159. such as transients, short and long duration voltage variations, interruptions, short and long voltage fluctuations, imbalance, flickers and transients. Symptoms of poor power quality. Definitions and terminology of grounding. Purpose of groundings. Good grounding practices and problems due to poor grounding. **6 Hrs**

Flickers & Transient Voltages:

RMS voltage variations in power system and voltage regulation per unit system, complex power. Principles of voltage regulation. Basic power flow and voltage drop. Various devices used for voltage regulation and impact of reactive power management. Various causes of voltage flicker and their effects. Short term and long term flickers. Various means to reduce flickers. Transient over voltages, sources, impulsive transients, switching transients, Effect of surge impedance and line termination, control of transient voltages. **8 Hrs**

Voltage Sag, Swells and Interruptions:

Voltage sags versus interruptions. Economic impact of voltage sag. Major causes and consequences. characteristics. assessment. Influence of fault location and fault level on voltage sag. Areas of vulnerability. Assessment of equipment sensitivity to voltage sags, CBEMA, ITIC, SEMI F 42 curves. Representation of the results of voltage sags analysis. Voltage sag indices. Mitigation measures for voltage sags, such as UPS, DVR, SMEs, CVT etc., utility solutions and end user solutions. **8 Hrs**

Waveform Distortion:

Definition of harmonics, Causes and effect of harmonics. Voltage versus current distortion. Harmonic indices. A.C. quantities under non-sinusoidal conditions. Triplen harmonics, characteristics and non characteristics harmonics. Harmonics series and parallel resonances. Consequences of harmonic resonance. Principles for controlling harmonics. Reducing harmonic currents in loads. K-rated transformer. Harmonic study procedure. Computer tools for harmonic analysis. Locating sources of harmonics. Harmonic filtering, passive and active filters. IEEE Harmonic standard 519-1992. **8 Hrs**

Power Quality Monitoring

Need of power quality monitoring and approaches followed in power quality monitoring. Power quality monitoring objectives and requirements. Initial site survey. Power quality Instrumentation. Selection of power quality monitors, selection of monitoring location and period. System wide and discrete power quality monitoring. Setting thresholds on monitors, data collection and analysis. Selection of transducers. Harmonic monitoring , Transient monitoring, event recording and flicker monitoring. **6 Hrs**

Text Books:

1. Electric Power Quality by Heydt, G T, Stars in a circle publications, Indiana 2nd edition-1994
2. Electrical Power System Quality , by R C Dugan, M.F Mcgranaghan, S. Santoso & H W Beaty, 3rd Edition TMH publication- 2008.

Reference Books:

1. Arrillaga J and Watson RN, Chen S, Power system Quality Assessment, Wiley New York-2000, 1st Edition.
2. Bollen M H J, Understanding Power Quality Problems, Voltage Sag and interruptions, Willy Publication NY-2000.

EE 6132 SOLAR POWER ENGINEERING Cr-3

Design of Solar Cells

Limits of cell parameter, losses in solar cell, solar cell design, Analytical techniques. **6 Hrs**

Solar Cell Technologies

Production of Si, Growth of solar PV industry and Si requirements, Production of MGS and EGS, Si wafer based solar cell technology, Thin film solar cell technologies, Concentrator PV cells and Systems, Emerging solar cell technologies and concepts. **6 Hrs**

Solar PV Application
Solar radiation, Sun tracking, estimating solar Radiation Empirically, Measurement of solar Radiation, Solar PV modules, Mismatch in series and parallel connection, Design and structure of PV Modules ,power output. **8 Hrs**

Balance of Solar PV Systems
Basic of electrochemical cell, Factors affecting the battery performance, Batteries for PV systems, Algorithm of MPPT, Charge controller. **8 Hrs**

Photovoltaic System Design

Introduction to Solar PV systems, Stand alone PV system configurations, Design methodology PV systems, Wire sizing in PV system, Precise sizing of PV systems, Hybrid PV systems, Grid connected PV systems, Simple payback period, Life cycle costing(LCC). **8 Hrs**

Text Books

1. Solar Photovoltaics Fundamentals, Technologies and Applications by Chetan Singh Solanki, PHI Publication, 2nd Edition, 2012.
2. Wind and solar systems by Mukund Patel, CRC Press, 1st Edition, 1999.

Reference Books

1. Solar Photovoltaics for terrestrials, Tapan Bhattacharya, 1998.
2. Energy Technology – S. Rao, Parulkar, (Khanna) 2009 Latest.

EE 6133 ADVANCED ELECTRICAL ENGINEERING MATERIALS Cr-3

Atoms and Aggregate of Atoms:

Structure of atom, electronic configuration, Bonds and bonding, crystallization of materials. Crystal symmetry and structure. Lattice arrangement of atom in materials, molecules and its structures, metallic and amorphous structures. **4 Hrs**

Insulating Materials:

Dielectric properties of insulators in static fields. The static dielectric constant, Polarization and dielectric constant. The atomic interpretation of the dielectric constant of monatomic gases. Qualitative remarks on the dielectric constants on polyatomic molecules, Quantitative discussion of the dielectric constant of polyatomic gases, the internal field in solid and liquids, the static dielectric constant of solids, Spontaneous polarization, Piezoelectricity. **6 Hrs**

Behavior of Dielectrics in Alternating Fields:

Frequency dependence of the electric polarization, Ionic polarization as function of frequency, the complex dielectric constant of non-polar solids. Dipolar relaxation, Dielectric losses. **3 Hrs**

Magnetic Properties of Materials:

Summary of concepts pertaining to magnetic fields; The magnetic dipole moment of a current loop, The magnetization from a microscopic view point, Orbital magnetic dipole moment and angular momentum of two simple atomic models, Lenz's Law and induced dipole moments. **4 Hrs**

Classification of Magnetic Materials:
Diamagnetism, The origin of permanent magnetic dipoles in matter, Paramagnetic spin system, Some properties of ferromagnetic materials, Spontaneous magnetization and the Curieweis's Law, Ferromagnetic domains and coercive force, Ant ferromagnetic materials, Ferromagnetic materials. **5 Hrs**

The Mechanism of Conduction in Semiconductors:

Classifying materials as semiconductors, The chemical bond in Si and Ge and its consequences. The density of carriers, intrinsic semiconductors, the energy gap, the conductivity of intrinsic semiconductors, Carrier densities in n-type semiconductors, P-type semiconductors, Hall effect and carrier density. **5 Hrs**

Conducting Materials:

General properties and specifications of pure copper and aluminum, factors affecting resistivity, wiedemanm Franz law, Materials and alloys for high conductivity, Characteristics of brass and different types of bronzes, Different types of solders, Metals and allowys for different types of fuses, fusing current and fuse ratings. Materials used for highly loaded metal contacts, electrical carbon material-characteristics of different carbon and graphite brushes. Materials of high resistivity, alloys for use in electrical resistance, arc-lamps and electric furnances, introduction to superconductivity. **6 Hrs**

Nanomaterials: Introduction, synthesis, and characterization; Description of basic energy carriers and nanostructures. **3 Hrs**

Text Book:
1. Electrical Engineering Materials – A.J. Dekker, PHI Publication
2. General and Electrical Engineering Materials-M.L. Gupta, New Hights Publishers, Delhi, 8th Edition.

Reference Book:
1. A Course in Electrical Engineering Materials – S.P. Seth & P.V. Gupta, Dhanpat Rai & Sons, 3rd Edition, 2003.

EE 6134 BIO-POWER ENGINEERING Cr-3

Introduction
Biomass and solid wastes, Broad classification, Production of biomass, photosynthesis, Separation of components of solid wastes and processing techniques, Agro and forestry residues utilization through conversion routes: biological, chemical and thermo chemical, Bioconversion into biogas, mechanism. **8 Hrs**

Composition and Conversion
Composting technique, Bioconversion of substrates into alcohols, Bioconversion into hydrogen, Thermo chemical conversion of biomass, conversion to solid, liquid and gaseous fuels, pyrolysis, gasification, combustion, Chemical conversion processes, hydrolysis and hydrogenation, Solvent extraction of hydrocarbons, Fuel combustion into electricity, case studies.

10 Hrs

Biomass Gasification
Bio-methenation technology, Bio-diesel, improved wood stove, Bio-hydrogen generation, Quality of Fuel Gas from Gasification and Bio-Methenation, Electricity from bio-mass.

8 Hrs

Bio Fuel
Solid, liquid and gaseous fuels, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, Principle of combustion, Petroleum and its derived products, Testing of liquid fuels, Petroleum refining processes, Inter-conversion of fuels, Natural gases and its derivatives, sources, potential, Gas hydrates, Combustion appliances for solid, liquid and gaseous fuels, Introduction to nuclear fuel, RDF, Bio-fuels, etc.

10 Hrs

Text Books
1. Non-conventional Energy Systems – Mittal, Wheelers Publication, 1999.

Reference Books
1. Energy Technology by S. Rao. & B. B Parulekar, Khanna Publisher Delhi, 1999, 3rd Edition.
2. Non conventional Energy Sources, by G D Rai, Khanna Publisher, 2011, latest.

EE 6135 ENERGY INSTRUMENTATION Cr-3

Basic Measurements:
Basic measurement concepts, Measurement errors, Essentials of measurement, implementation and scope of instrumentation; Performance characteristics, accuracy, response time, reliability and availability, types of equipment. Transducer classification, Static and dynamic characteristics of transducers. **6Hrs**

Unit-2: Measurement Techniques and Instruments:
Instruments for measuring temperature, pressure, velocity and flow, heat flux, liquid level and concentration in energy systems, characterization of combustors, Flue gas analysers, Exhaust gas analysers, Solar energy measurement requirements and instruments, Meteorological data measurements, Energy auditing instruments, Energy audit kit, humidity measurement, characterization of electrical power systems, Strip-chart and X-Y recorders of galvanometric and servo types- magnetic recorder; FM recording technique; Indicating and display devices. **8 Hrs**

Control room Instrumentation:
Instruments for monitoring electrical parameters, Analysis of power system measurements. Analog signal conditioning, A/D and D/A converters, Digital data processing and display, Design factors and validation, operator interface and ergonomics, computer based displays. DC, AC pulse and digital telemetry, signal transmission media. **8 Hrs**

Elements and Functions of SCADA System:
Automatic controllers closed loop control; On-off, proportional, PI and PID controllers, pneumatic and electronic controllers, automatic controllers in hydro-electric plant. **6 Hrs**

Air pollution Measurement:
Computer data processing and control, Feed back control system, Stability and transient analysis of control systems, Application of PID controllers, General purpose control devices and controller design, Air pollution sampling and measurement of particulates, SOx, NOx, CO, O_3, hydrocarbon. **8 Hrs**

Text Books:
1. Analysis and design of Energy Systems by Hogde B.K. (Prentice hall1988)
2. Energy management and control system –VolI,II – M.C.Macedo (john Wiley and Sons).

EE 6136 WIND POWER ENGINEERING Cr-3

Wind Power
Wind Power in India, IEC Standards for Wind Turbines, State Government Policy for Wind Power Project Investment. Wind Characteristics: Power in the wind: Conversion of Wind to Electric Energy: **6 Hrs**

Wind Power Plant
Types of Wind Power Plant: Components of Wind Power Plants: Working of Wind Power Plants: Aerodynamic Power Regulation of Wind Power Plants:Specifications of Wind Power Plants: Electrical Power Control Strategies: **8 Hrs**

Major Power Electronics Components in Wind Power Plants
Power Electronics Wind Power Plants: Type-A WPP with Squirrel cage Induction generator:
Type-B WPP with Wound Rotor Induction generator: Type-C WPP with Doubly-fed Induction generator: Type-D WPP with Wound Rotor Synchronous generator: Type-D WPP with Permanent Magnet Synchronous generator. **10 Hrs**

Economics of Wind Power Plants
Wind Power Quality and Electrical Generators: Grid Integration of Wind Power Plants: Wind resource Assessment: Siting of Wind Power Plants: Economics of Wind Power Plants: Choice of Wind Turbines: Wind Power Project development. **6 Hrs**

Maintenance of Wind Power Plant components
Wind Power Policy: Wind Power and the Environment: Wind Power Planning: Public Perception and Acceptance: Operation and Maintenance Issues of Wind power Plants: Maintenance of Wind Power Plant components. **6 Hrs**

Text Books
1. Wind Power Plants and Project Development by Joshua Earnest, Tore Wizelius, PHI Publication, 1st Edition, 2011.
2. Wind Energy Technology – Njenkins, John Wiley & Sons, 1st Edition, 1997.

Reference Books
1. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley

EE 6137 ADVANCED ENERGY CONVERSION SYSTEM Cr-3

Latest Topics on Energy
Integrated Gasification combined cycle (IGCC), Fuels for power generation, advanced energy storage systems, Hydrogen power, clean coal technologies, Pressurized fluidized bed combustion, Natural gas cycles, integrated generation. **8 Hrs**

Nuclear Energy Conversion
Chemical and nuclear equations – Nuclear reactions – Fission and fusion – Energy from fission and fuel burn-up - Radioactivity – Neutron energies – Fission reactor types – Nuclear power plants – Fast breeder reactor and power plants – Production of nuclear fuels. **7 Hrs**

Gas Turbine and Combined Cycle Analysis
Inter-cooling, reheating and regeneration-gas turbine cooling – design for high temperature – Combined cycles with heat recovery boiler – Combined cycles with multi-pressure steam – STAG combined cycle power plant – Influence of component efficiencies on cycle performance. **7 Hrs**

Co-Generation & Tri-Generation:
Definition, need, application, advantages, classification, saving Potential. Waste Heat Recovery: Concept of conversion efficiency, energy waste, waste heat recovery classification, advantages and applications, commercially viable waste heat recovery devices. **7 Hrs**

Fuel Cells: Energy conservation in power plant. **3 Hrs**

Battery Vehicles: Electric vehicles, Algal bio fuels, Metal hydrates, Geological CO_2 sequestering. **4Hrs**

Text Books:

1. M.M. El- Wakil; Power Plant Technology, McGraw Hill, 1984.
2. A.W. Culp Jr; Principles of Energy Conversion, McGraw Hill, 1979.
3. H.A. Sorensen: Energy Conversion Systems, J. Wiley, 1983.

Reference Books:

1. T.F. Morse: Power Plant Engineering, Affiliated East West Press, 1978.
2. M.M. E1-Wakil: Nuclear Power Engineering, McGraw Hill, 1962.
3. R.H.S. Winterton: Thermal Design of Nuclear Reactors, Pergamon Press, 1981.
4. R.L. Murray: Introduction to Nuclear Engineering, Prentics Hall, 1961
5. Practical Heat Recovery – Boyen J.L. (John Wiley, New York, USA1976)

EE 6138 ENERGY MANAGEMENT AND AUDIT Cr-3

General Aspects:
Definitions of Energy Efficiencies, Estimation of Energy efficiencies in supply side and demand side, definition of energy conservation, management and audit, similarities and dissimilarities in financial audit and energy audit, approach, data collection and data analysis methodologies, demand and supply matching methodologies, optimization methodologies in input and output, economical and ecological implications on management & auditing systems, auditing on emission, pollution, safety and reliability. **12 Hrs**

Procedure and Techniques:
Input and output analysis of an product and process systems, Data collection and analysis methodologies, applications of computers in data analysis, Data collection methodologies in thermal, electrical, chemical energy systems, loss analysis methodologies in thermal, electrical and chemical systems and evaluation of energy & material saving opportunities, cost benefit analysis on saving opportunities, development of total energy systems. **12 Hrs**

Applications of Energy Audit:
Energy auditing methodologies in boiler and firing systems, Energy conservation opportunities in power stations through energy auditing, auditing in transmission and distribution systems, process industries, service industries, building and habitat systems, Implication methodologies of enhancing energy efficiencies, Audit report preparation methodologies.
12 Hrs

Text Books:

1. W.R. Murphy and G. McKay, "Energy management", Butterworth & Co Publishers, Oxford, UK, 2003.
2. Energy Audit of Building systems: An Engineering approach, by:Moncef krarti, CRC PRESS, Second Edition,2009.

Reference Books:

1. A Workbook for Energy Management in building by: Tarik Al-Shemmeri, Wiley-Blackwell, 2011.
2. Energy audit: Thermal power , combined cycle, and co-generation plants, by:Y.P Abbi, TERI, 2012.

EE 6139 ILLUMINATION ENGINEERING Cr-3

Introduction
Light and electromagnetic radiation, sources of light- thermal radiator-blackbody radiator, laws of thermal radiation, daylight and artificial light, spectral power distribution (SPD) of light sources. **6 Hrs**

Visual system
Structure, external factors of vision, continuous adjustment- photopic, scotopic and mesopic capabilities, perception, CIE standard observer, Glare- discomfort & disability glare. **4 Hrs**

Colorimetric
Dichromatic vision, RGB colour specification system, CIE 1931 XYZ colour specification system, source colour & object colour specification, CIE standard illuminant. Radiometric and photometric quantities, relation between Lumen and Watt, photometric standards. **6 Hrs**

Photometry
Measurement of luminous flux, illuminance, luminance, luminous intensity distribution.
Computation of lumen output from luminous intensity distribution of a source, computation of CCT and CRI from CIE 1931 chromaticity diagram. **6 Hrs**

Different types of Lamps
Its characteristics & Applications, Luminaire- its function and classification, Lamp and luminaire specifications. **4 Hrs**

Basic concepts of lighting design
design objectives, design parameters, qualitative & quantitative evaluation of lighting systems, Energy management in illumination, Energy efficient illuminating system components, energy oriented new and retrofit installations, Power Quality, Demand side management (DSM). **6 Hrs**

Maintenance of lighting system
Indoor and outdoor, maintenance schedule, scheme, Relamping-spot and group, Equipment and materials used for maintenance job, General Guidelines on disposal of burnt out lamps. **4 Hrs**

Text Books
1. Energy Management in Illumination Systems – Kao Chen, CRC Press, 1999.
2. Lamps and Lighting – Edited by J.R.Coaton and A.M.Marsden, 4th Edition, 2011.

Reference Books
1. Lighting for energy efficient luminous environments- Ronald N.Helms & M Clay Belcher. Prentice Hall, 2012.
2. Fundamentals of Illumination Engineering – V.V.Meshkov, Mir Publication, Russia, 2008.
3. The Scientific Basis of Illuminating Engineering – P.Moon Dover Publications, 2008.

EE 6140 ENERGY AND ENVIRONMENTAL IMPACT ANALYSIS Cr-4

Energy & Ecology:
Interrelationship between energy, ecology and environment, Sun as a source of energy, nature of its radiation, Biological processes, Photosynthesis, Autecology and synecology, Population, Community, Ecosystems (wetland, terrestrial, marine), Food chains, Ecosystem theories. **8 Hrs**

Environmental Impacts:

Biological effects of radiation, Heat and radioactivity disposal, Environmental degradation due to energy production and utilization, Primary and secondary pollution, air, thermal and water pollution, Acid rain, depletion of ozone layer, global warming, biological damage due to environmental degradation. Methods of Environmental Impact Assessment. Socioeconomic environment, Evaluation alternatives, Public participation in environmental decision making. **8 Hrs**

Pollution:

Pollution sources and classification, air, water, soil and noise sampling and monitoring, Instrumentation, Environmental issues related to harnessing of fossil fuels (coal, oil,natural gas, geothermal, tidal, nuclear energy, solar,wind, hydropower, biomass, Energy flow and nutrient cycling in ecosystems, Environmental degradation, Primary and secondary pollutants. Thermal/ radioactive pollution, Air & water pollution, Micro climatic effects of pollution, Pollution from stationary and mobile sources. **8 Hrs**

Industrial Waste:

Industrial waste, Waste and effluent treatment, Waste as a source of energy: Industrial, domestic and solid waste as a source of energy. Pollution control: Causes, process and exhaust gases and its control, mechanism and devices for pollution control. **6 Hrs**

Global Environmental Concern:

United Nations Framework Convention on Climate Change (UNFCC), Protocol, Conference of Parties (COP) Clean Development Mechanism (CDM), Prototype Carbon Funds. Carbon Credits and it's trading, Benefits to developing countries, Building a CDM project. **6 Hrs**

Text Books:

1. Renewable Energies and Carbondioxide Cost Analysis, Environmental Impacts and Technological Trends-2011, by: Ricardo Guerrero-Lemus, Jose Manual Martinez Duart, and Springer.
2. Managing Environmental Pollution, by: Andrew Farmer, Routeledge environmental management series.

Reference Books:

1. Industrial waste Treatment Handbook, by: Frank Woodard, 2001.
2. Management of Energy Environment Systems W.K.Foell (John Wiley and Sons).
3. Energy & Environment – J.M. Fowler,(McGrawHill)

SCHOOL OF ELECTRICAL ENGINEERING

SPECIALISATION: POWER ELECTRONICS & DRIVES

EE 6201 GENERALIZED THEORY OF ELECTRICAL MACHINES Cr-4

SYNCHRONOUS MACHINES
Synchronous machines : The basis of general theory, General equations of AC machines, Parks transformation, Derivations of two axis equations and simplified equation of synchronous machine with two damper winding. Equivalent circuits, operational impedances, Synchronous Generator short circuit and system faults. **12 Hrs**

CONSTANT FLUX LINKAGE THEOREMS
Constant flux linkage theorems, its application to three phase alternator, sudden 3-phase short circuit on a 3-phase unloaded alternator, Analysis of short circuit oscillogram. System fault calculation, Short circuit of a loaded alternator, line to line short circuit, equivalent circuit under transient condition. Simplified phasor diagram for transient condition. Induction Machines: general equation of induction motor (Part & Cron's equation) Short circuit and fault calculation due to 3-phase induction motor. **12 Hrs**

TRANSFORMER:
Pver voltage in transformer, its characteristics, equivalent circuit under voltage surge condition. Simplified equivalent circuit, Increase of terminal voltage due to voltage surge. Initial , final and intermediate voltage distribution under surge condition. Protection against surges, Mechanical forces in transformer and its estimation in two winding and three winding transformer. Calculation of stress in windings. **12 Hrs**

CHARACTERISTICS OF TRANSFORMER :
Terminal characteristics of transformer, temperature rise calculation under constant continuous loads, varying loads and periodically changing loads, Aging of insulation, Switching in phenomena, inrush current and effect of short circuit, construction , analysis and application of brushless DC motor, variable reluctance motor and stepper motor. **12 Hrs**

Text Books:
1. Generalized Theory of Alternating Current Machine by B.Adikin's R G Harley Chapman & Hall, 1959, 2nd Edition.
2. Principle Operation and Design of Power Transformer by Vascitinsky S B , 2004

Reference Book:
1. Generalized Theory of Electrical Machine by P.S. Bimbhra Khanna Publications, 2006.

EE 6202 ADVANCED ELECTRIC DRIVES Cr-4

VECTOR CONTROLLER INDUCTION MOTOR DRIVE:
Dynamic d-q model of 3 phase induction motor d-q equivalent circuit(stator, rotor, synchronously rotating reference frames model), equation of flux linkage, small signal equations of induction motor, dynamic model state space equations, Principles of vector control, direct vector control, implementation with voltage source, Derivation of indirect vector control scheme. **12 Hrs**

PARAMETER COMPENSATION:
Parameter sensitivity of the indirect vector controller induction motor drive, Parameter Sensitivity compensation, Speed-Controller design for an indirect vector controller induction motor drive, Sensorless vector control. **12 Hrs**

PERMANENT- MAGNET SYNCHRONOUS MOTOR DRIVES:
Permanent magnet – Synchronous and Brush less DC motor drive: Equivalent circuits of synchronous machines, Developed torque dynamic d-q machine model of synchronous machine, synchronous reluctance machine, permanent magnet machine, permanent magnet materials and characteristics, sinusoidal interior magnet machine trapezoidal surface magnet machine, variable reluctance machine. **12 Hrs**

VECTOR CONTROL SYNCHRONOUS MOTOR DRIVES:
Vector control of PM synchronous machine, control strategies (constant torque angle control, unit power factor control, constant flux linkage control, optimum torque per ampere control). Flux weakening operation, Speed – controller design, Sensor less control, PM Brush less DC motor(PMBDCM), Modeling of PM Brush less DC motor. The PMBDCM Drive scheme. Half wave PMBDCM Drives operation of the PMBDCM motor with the split-supply converter topology.

Synchronous reluctance- Machine drives. Current vector control of synchronous reluctance motor drive. Switched Reluctance motor drives. **12 Hrs**

Text Books:

1. Electric Motor Drives Modeling , Analysis and Control by R. Krishnan , PHI, 2010
2. Electrical Motor Drives (Modeling, Analysis and Control) by Bimal Kumar Bose (PHI Publication), 2006.

Reference Book:

1. Modern Power Electronics & AC Drives by Bimal Kumar Bose (Pearson Education), 2009.
2. Vector control dynamics of AC drives T W Novotony T A Lipo , Oxford science Publication , 2012
3. Neural and Fuzzy logic control of drives and power system, M N Cirstea, A. Dinu, J G Khor, M Mcormic, Elsiever, 2011

EE 6203 POWER ELECTRONIC CONVERTER-I Cr-4

DEVICES:

Review of Thyristor, Triac and Diac MOSFET structure, dynamic characteristics, Comparison with BJT, IGBT structure, dynamic characteristics, protection.GTO characteristics, Firing circuit.,SiC based power devices. General characteristics. The types of devices available commercially. **10 Hrs**

AC-DC CONVERTER:

Single Phase Converters, Performance Parameters, 3 Phase Converters, Semi Converters, Dual Converters. Power Factor improvement Techniques: Extinction angle Control, Symmetric angle Control, 3 Phase Converters, Semi Converters, Dual Converters. **10 Hrs**

AC-AC CONVERTER:

Single Phase & 3 Phase AC regulators, Single Phase & 3 faze Cyclo-Converters Single Phase Converters, Performance Parameters. **8 Hrs**

DC-DC CONVERTER:

Chopper Circuits: Principles of Step Down and Step Up configurations, 4 Quadrant operations, Buck Regulator, Boost Regulator, Buck-Boost Regulator, Cuk Regulator. **10 Hrs**

DC-AC CONVERTER:

Single Phase Half Bridge and Full Bridge Inverters, Performance Parameters3 Phase Inverters, 180 ° & 120 ° Conduction, Voltage Control of inverters:Sinusoidal PWM, Unipolar and Bipolar switching scheme, Push Pull Inverters.Current source Inverters. **10 Hrs**

Text Books :

1. Power Electronics Circuits, Devices, Applications (3rd Edition) By M.H. Rashid.
2. Power Electronics, Converters, Applications & Design N. Mohan, Undeland & Robbins.

EE 6204 POWER ELECTRONIC CONVERTER-II Cr-4

Introduction:

Power Electronic circuit design PWM techniques for inverters. Multi level Inverters. **12 Hrs**

Resonant Converters:

Classification of resonant converters, Basic resonant circuit concepts, Series Resonant Inverters, half bridge and full bridge. Series loaded resonant converters. Parallel loaded resonant converters. Class E resonant converters. Quasi Resonant converters: ZCS & ZVS resonant switch converters. ZVS buck converter. **18 Hrs**

Switch Mode Power Supply:

Overview, DC – DC converters with isolation. Fly Back Converters. Forward Converters. Design of Filter Inductor for Switching Regulators. Design of Transformer for Fly Back and Forward converters. Design of Filter Capacitor for fly back converter. Push – Pull Converter, Half Bridge & Full Bridge Converters. Control of SMPS. **18 Hrs**

Text Books:

1. Power Electronics Circuits, Devices, Applications (3rd Edition) By M.H. Rashid, 2004.
2. Power Electronics, Converters, Applications & Design N. Mohan, Undeland & Robbins, 2004.

EE 6205 ELECTRIC DRIVE SYSTEM Cr-4

Dynamics of Electrical Drives
Basic Parameters of Electric Drive, Types of load, Equivalent values of drive parameters, Multi quadrant operation, steady state stability, Calculation of time and energy losses transient operation. **10 Hrs**

PHASE CONTROLLED DC MOTORS DRIVES
Principle of DC motor speed control, Four quadrant operation, phase controlled DC drive(Single phase and three phase) , Steady state analysis of three phase control DC motor drive. Closed loop control , Transfer functioning of DC motor load. **10 Hrs**

CHOPPER CONTROLLER DC DRIVE
Principle of operation of the chopper in four quadrants, steady state analysis of chopper control DC motor drives. **8 Hrs**

INDUCTION MOTOR DRIVE:
Torque- speed characteristics of 3-phase induction motor drive, Equivalent circuit diagram, Variable- voltage, constant frequency operation, Constant Volt/Hz operation. Drive operating region. Variable stator current operation. The effects of harmonics torque pulsation. Stator voltage control steady state analysis. Voltage –source inverter driven induction motor drive and control strategies and its implementation. Current source induction motor drives and its implementation, Slip energy recovery scheme. **10 Hrs**

Text Books:

1. Fundamentals of Electric drives by G.K. Dubey Narosa publishing House, 3rd Edition, 2002
2. Electric Motor Drives Modeling Analysis and Control by R Krishnan PHI 2nd edition 2002

Reference Book:

1. Electric Drives by M. Chilkin Mir Publishers Moscow, 2nd Edition, 1997
2. Fundamentals of Electric Drives by Mohammad A. EI-Sharkawi, Thomson Asia Pvt Ltd, Singapore, 2007
3. Electric drives concept and application by Vedam Subrahmanyam, TMH, 2012
4. A first course of electrical drives by S K Pilai New age International Publisher, revised Edition 2013

EE 6207 POWER ELECTRONICS AND DRIVES Cr-3

Converters:

Single Phase Converters with R, RL & RLE load, Line Commutated Inverters, Three Phase Converters, Effect of Source inductance in 1 Phase & 3 Phase Converters, Semi Converters, Performance Parameters, 1 Phase & 3 Phase Dual Converters.Single Phase AC regulators, Single Phase Cyclo-Converters. Power Factor improvement Techniques: Extinction angle Control, Symmetric angle Control, PWM Control. **12Hrs**

Chopper Circuits:
Principles of Step Down and Step Up configurations,4 Quadrant operation, Buck Regulator, Boost Regulator, Buck-Boost Regulator, Circuit Regulator. **6 Hrs**

Inverter:
Single Phase Half Bridge and Full Bridge Inverters, Performance Parameters, 3 Phase Inverters, 180 ° & 120 ° Conduction, Voltage Control of inverters: Sinusoidal PWM, Unipolar and Bipolar switching scheme. **8 Hrs**

Electric drives:
Basic elements of electric drives, 4 quadrant operation of electric drives. Review of characteristics of DC motors, and induction motors. Calculation of equivalent moment of inertia of drive system and load equalization. Phase controlled and Chopper controlled DC drive. Control of Induction Motor by AC –AC Voltage controller, PWM Inverter fed induction motor drives. Concept of V/f control. Concept of Stepper motors and control. AC and DC servo motors. **10 Hrs**

Text Books:

3. Power Electronics by M. H. Rashid, Pearson Education, 3rd Edition, 2008.
4. Power Electronics by N Mohan, Undeland and Robbins, John Wiley and Sons, 3rd Edition, 2007.

Reference Books:
1. Power Electronics, by P S Bhimbra, , Khanna Publishers, 5th Edition, 2012.
2. Fundamentals of Electric Drives by G.K.Dubey Narosa publishing House, 3rd Edition, 2002.

EE 6221 INDUSTRIAL INSTRUMENTATION AND TRANSDUCERS Cr-3

Measurement of Force, Torque and Velocity:
Electric balance – Different types of load cells – Magnets – Elastic load cells - Strain gauge load cell – Different methods of torque measurement – Strain gauge, relative regular twist – Speed measurement – Revolution counter – Capacitive tacho-drag cup type tacho – D.C and A.C tacho generators – Stroboscope. **5 Hrs**

Measurement of Acceleration, Vibration, Density and Viscosity:
Accelerometers – LVDT, piezoelectric, strain gauge and variable reluctance type accelerometers – Mechanical type vibration instruments – Seismic instrument as an accelerometer and vibrometer – Calibration of vibration pick-ups – Units of density, specific gravity and viscosity used in industries – Baume scale. **5 Hrs**

Pressure Measurement:
Units of pressure – Manometers- Different types – Elastic type pressure gauges – Bourdon type bellows-Diaphragms-Electrical methods – Elastic elements with LVDT & strain gauges -Capacitive type pressure gauge- Piezo resistive pressure sensor- Resonator pressure sensor- Measurement of vacuum- McLeod gauge-Thermal conductivity gauges. **5 Hrs**

Temperature Measurement
Definitions and standards – Primary and secondary fixed points – Calibration of thermometer, different types of filled in system thermometer – Sources of errors in filled in systems and their compensation – Bimetallic thermometers – Electrical methods of temperature measurement – Signal conditioning of industrial RTDs and their characteristics – Three lead and four lead RTDs. **5 Hrs**

Thermocouples and Pyrometers
Thermocouples – Laws of thermocouple – Fabrication of industrial thermocouples – Signal conditioning of thermocouples output – Thermal block reference functions – Commercial circuits for cold junction compensation – Response of thermocouple – Special techniques for measuring high temperature using thermocouples – Radiation methods of temperature measurement – Radiation fundamentals – Total radiation & selective radiation pyrometers – Optical pyrometer. **5 Hrs**

Measurement in Thermal Power Plant
Selection, Installation and maintenance of Instruments used for the measurement of fuel flow, Air flow, Drum level, Steam pressure, Steam temperature and other parameters in thermal power plant – Analyzers - Dissolved Oxygen Analyzers- Flue gas Oxygen Analyzers-pH measurement- Coal/Oil Analyzer – Pollution Controlling Instruments. **5 Hrs**

Energy management device
Electrical and intrinsic safety - Explosion suppression and deluge systems – Flame arrestors, conservation vents and emergency vents – Flame, fire and smoke Detectors- Metal detectors. Special Purpose Instrumentation Toxic gas monitoring- Detection of Nuclear radiation – Water quality monitoring- Monitor measurement by neutron-Thermo-luminescent detectors – Measurement of length, mass, thickness, flow, level using nuclear radiation. **6 Hrs**

Text Books
1. E.O. Doebelin, 'Measurement Systems – Application and Design', Tata McGraw Hill publishing company, 2003.
2. D. Patranabis, 'Principles of Industrial Instrumentation', Tata McGraw Hill Publishing Company Ltd, 1996, 2nd Edition, 2008.

Reference Books

1. A.K. Sawhney and P. Sawhney, 'A Course on Mechanical Measurements, Instrumentation and Control', Dhanpath Rai and Co, 19th Edition, 2008.
2. B.C. Nakra & K.K.Chaudary, 'Instrumentation Measurement & Analysis', Tata Mc Graw Hill Publishing Ltd, 2009 MGH.
3. S.K. Singh, 'Industrial Instrumentation and Control', Tata McGraw Hill, 2010.
4. D.P. Eckman', Industrial Ins 2. John G Webster, Measurement, Instrumentation and Sensors Handbook, CRC press IEEE press
5. Liptak B.G, Instrument Engineers Handbook (Measurement), Chilton Book Co., 1994. 4. Reay D.A, 4th Edition, 2003. Industrial Energy Conservation, Pergamon Press, 1977.
6. Hodge B.K, Analysis and Design of energy systems, Prentice Hall, 1988-1998 PHI.
7. Liptak B.G, Instrument Engineers Handbook, Clinton Book Company, 1982
8. Ness S.A. Air monitoring for Toxic explosions, Air integrated Approach, Von Nostrand,1991.
9. Ewing G., Analytical Instrumentation hand book, Dekkea, 199 trumentation', Wiley Eastern Ltd., 3rd Edition.

EE-6222 DYNAMICS OF POWER ELECTRONICS CONVERTER Cr-3

Power System Harmonics and Line Commutated Rectifiers

Average power-RMS value of a waveform-Power factor-AC line current harmonic standards IEC 1000-IEEE 519- The Single phase full wave rectifier-Continuous Conduction Mode-Discontinuous Conduction Mode-Behaviour when C is large- Minimizing THD when C is small-Three phase rectifiers- Continuous Conduction Mode-Discontinuous Conduction Mode- harmonic trap filters. **5 Hrs**

Pulse Width Modulated Rectifiers

Properties of Ideal rectifiers-Realization of non ideal rectifier-Control of current waveform-Average current control-Current programmed Control- Hysteresis control- Nonlinear carrier control-Single phase converter system incorporating ideal rectifiers-Modeling losses and efficiency in CCM high quality rectifiers-Boost rectifier. **5 Hrs**

Resonant Converters

Review on Parallel and Series Resonant Switches-Soft Switching- Zero Current Switching - Zero Voltage Switching - Classification of Quasi resonant switches-Zero Current Switching of Quasi Resonant Buck converter,Zero Current Switching of Quasi Resonant Boost converter, Zero Voltage Switching ofQuasi Resonant Buck converter, Zero Voltage Switching of Quasi Resonant Boost converter: Steady State analysis. **10 Hrs**

Dynamic Anlysis of Switching Converters

Review of linear system analysis-State Space Averaging-Basic State Space Average Model-State Space Averaged model for an ideal Buck Converter, ideal Boost Converter, ideal Buck Boost Converter, for an ideal Cuk Converter.Flyback converter. **10 Hrs**

Control of DC-DC Converters

Pulse Width Modulation-Voltage Mode PWM Scheme-Current Mode PWM Scheme-Peak current control, hysteresis band control, Variable Structure Controller. **6 Hrs**

Text Book:

1. Elements of Power Electronics ,Philip T.Krein,Oxford University press,Newyork, 2009.

Reference Books :

1. Robert W. Erickson &Dragon Maksimovic" Fundamentals of Power Electronics" Second Edition, 2001 Springer science and Business media, 2005.
2. William Shepherd and Li zhang" Power Converters Circuits"Marceld Ekkerin, C, 2004.
3. Simon Ang and Alejandro Oliva "Power- SwitchingConverters" Taylor & Francis Group, 2nd Edition.

EE 6223 ADVANCED MICROPROCESSORS & APPLICATIONS Cr-3

8086 Microprocessor:

Review of 8086 Architecture, pins and Signals, Minimum and maximum mode configurations, Interrupts, 8086 Addressing modes, Instructions and Programming. **13 Hrs**

8051 MC:

Introduction, over view of 8051 family. Architecture of 8051 MC, Addressing modes, Instructionsets, timer & counter, simple programming. **8 Hrs**

Pic Microcontroller:

Pic microcontroller, over view and features. PIC 16C6X/7X, FSR, PIC memory organization, PIC 16C 6X/7X instructions & programming Addressing modes, I/O ports, Interrupts , PIC 16 C71 ADC. **10 Hrs**

Industrial Applications of Microcontrollers:

Automation and control Applications: Digital PID controller, Microcontroller based PWM control of a DC motor using ICA 395. Microcontroller based stepper motor control using 89C2051. **5 Hrs**

Text Books:

1. Microcontrollers (Theory & applications) by Desmukh. TMH, 2005 MGH.
2. Advanced Microprocessors and Peripherals by A K Raj and K m Bhurchandi, Tata Mc Brow Hill Publication 2009.

Reference Books:

1. The Intel Microprocessors 8086-Pentium; Badri Ram, THM, 1988.
2. Microprocessor and Micro controller By R.Theagaragan , scitech publication.

EE6231 POWER SEMICONDUCTOR DEVICES Cr-3

Introduction

Power switching devices overview – Attributes of an ideal switch, application requirements, circuit symbols; Power handling capability – (SOA); Device selection strategy – On-state and switching losses – EMI due to switching - Power diodes -Types, forward and reverse characteristics, switching characteristics – rating. **5 Hrs**

Current Controlled Devices

BJT's – Construction, static characteristics, switching characteristics; Negative temperature co-efficient and secondary breakdown; Power darlington - Thyristors – Physical and electrical principle underlying operating mode, Two transistor analogy – concept of latching; Gate and switching characteristics; converter grade and inverter grade and other types; series and parallel operation; comparison of BJT and Thyristor – steady state and dynamic models of BJT & Thyristor. **8 Hrs**

Voltage Controlled Devices:

Power MOSFETs and IGBTs – Principle of voltage controlled devices, construction, types, static and switching characteristics, steadystate and dynamic models of MOSFET and IGBTs - Basics of GTO, MCT, FCT, RCT and IGCT. **8 Hrs**

Firing and Protecting Circuits

Necessity of isolation, pulse transformer, optocoupler – Gate drives circuit: SCR, MOSFET, IGBTs and base driving for power BJT. - Over voltage, over current and gate protections; Design of snubbers. **8 Hrs**

Thermal Protection

Heat transfer – conduction, convection and radiation; Cooling – liquid cooling, vapour –phase cooling; Guidance for hear sink selection – Thermal resistance and impedance - Electrical analogy of thermal components, heat sinktypes and design – Mounting types. **7 Hrs**

Text Books

1. B.W Williams 'Power Electronics Circuit Devicesand Applications', Willy pup, 2009.
2. Rashid M.H., " Power Electronics Circuits, Devices and Applications ", Prentice Hall India, Third Edition, New Delhi, 2004.

References Books:

1. MD Singh and K.B Khanchandani, "Power Electronics", Tata McGraw Hill, 2001, 2nd Edition,
2. Mohan, Undcland and Robins, "Power Electronics-Concepts, applications andDesign, John Wiley and Sons, Singapore, 3rd Edition, 2003.

EE-6232 TRACTION AND HYBRID ELECTRIC VEHICLE Cr-3

Introduction to Hybrid Electric Vehicles:
History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **5 Hrs**

Conventional Vehicles:
Basics of vehicle performance, vehicle power source characterization, transmission characteristics, and mathematical models to describe vehicle performance. **6 Hrs**

Electric Propulsion unit:
Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency. **10 Hrs**

Energy Storage:
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. **7 Hrs**

Electric Drive-Trains:
Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Calculation of tractive effort, Electrical Motors for traction, Power Electric converters in modern traction practice. AC drives in Electric Traction. **8 Hrs**

Text Book:

1. Hybrid Electric Vehicle, Chris Mi, M. Abul Masrur, David Wenzhong GAO, John Wiley & Sons, Ltd, 2011.
2. Fundamentals of Electric Drives by G K Dubey Narosa publishing House, 3rd Edition, 2002.

Reference Book:

1. Electric traction By H.Pratab, Jain book 2014 latest, 2011.

EE 6233 ADVANCED DIGITAL SIGNAL PROCESSING Cr-3

Introduction
Mathematical description of change of sampling rate– Interpolation andDecimation, Filter implementation for sampling rate conversion – direct form FIRstructures, DTFT, FFT, Wavelet transform and filter bank implementation ofwavelet expansion of signals. **6 Hrs**

Estimation and Prediction Techniques
Discrete Random Processes – Ensemble averages, Stationary processes, Autocorrelation and Auto covariance matrices. Parseval's Theorem, Wiener- Khintchine Relation – Power Spectral Density AR, MA, ARMA model based spectral estimation. Parameter Estimation, Linear prediction – Forward and backward predictions, Least mean squared error criterion – Wiener filter for filtering and prediction, Discrete Kalman filter. **10 Hrs**

Digital Signal Processor
Basic Architecture – Computational building blocks,MAC, Bus Architecture and memory, Data Addressing, Parallelism and pipelining, Parallel I/O interface, Memory Interface, Interrupt, DMA. **10 Hrs**

Application of DSP
Design of Decimation and Interpolation Filter,FFT Algorithm, PID Controller, Application for Serial Interfacing, DSP based PowerMeter, Position control. **5 Hrs**

VLSI Implementation
Basics on DSP system architecture design using VHDL programming, Mapping of DSP algorithm onto hardware, Realisation of MAC & Filter structure. **5 Hrs**

Text Books:

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modelling", JohnWiley and Sons, Inc, 2009 latest.
2. John G. Proaks, Dimitris G. Manolakis, "DigitalSignal Processing", PearsonEducation, 4th Edition, 2006.

References Books:

1. Bernard Widrow, Samuel D. Stearns, Adaptive Signal Processing", Pearson Education, third edition, 2004.
2. Dionitris G. Manolakis, Vinay K. Ingle, Stepen M. Kogon,"Statistical & Adaptive signal processing, spectral estimation, signal modeling, Adaptivefiltering & Array processing", McGraw-Hill International edition 2000.
3. S. Salivahanan, A. Vallavaraj and C. Gnanapriya"Digital Signal Processing", TMH,2000.
4. Avatar Sing, S. Srinivasan, "Digital Signal Processing- Implementation using DSP Microprocessors with Examples from TMS320C54xx", Thomson India,2004.
5. Lars Wanhammer, "DSP Integrated Circuits", Academic press, 1999, New York.
6. Ashok Ambardar,"Digital Signal Processing: A Modern Introduction", Thomson India edition, 2007.
7. Lars Wanhammer, "DSP Integrated Circuits", Academic press, 1999,New York.

SCHOOL OF ELECTRONICS ENGINEERING

SPECIALIZATION: COMMUNICATION SYSTEM ENGINEERING

EC6101 ADVANCED DIGITAL COMMUNICATION TECHNIQUES Cr – 4

Digital Modulation Schemes: Memory-less modulation method, QAM signalling with memory, Continuous-Phase Frequency Shift Keying (CPFSK), Continuous-Phase Modulation (CPM), Power Spectral Density (PSD): digital signal with memory, linearly modulated signal with finite mean; PSD of CFPSK and CPM signals. **10 Hrs**

Principles of Detection Theory: Binary and m-ary hypothesis testing. Multi-hypothesis testing; sufficient statistics; Baye's likelihood ratio test. **5 Hrs**

Optimum Receiver for AWGN Channels: Correlation Receiver, Matched filter receiver, optimal detection, error probability for band limited signal, optimal detection, detection of signalling schemes with memory performance analysis for wire-line and radio communication. **8 Hrs**

Synchronization: Carrier phase estimation (maximum likelihood, phase lock looped, decision-directed loop), symbol time estimation (maximum likelihood, non-decision-directed timing estimation), joint estimation of carrier phase and symbol timing. **7 Hrs**

Digital Communication through Band-Limited Channels: Band-limited channel; characterization, optimal receiver for band-limited channels with ISI and AWGN. **7 Hrs**

Linear equalization Adaptive Equalization: Equalization (peak distortion criteria, Mean Square Error (MSE) criteria), decision feedback equalizer, zero forcing, LMS, adaptive decision feedback, recursive least square (Kalman), blind equalization. **11 Hrs**

Text Books:

1. *John G. Proakis and Masoud Salehi: Digital Communication, 5th Edition, McGraw hill International, 2008*
2. *Amos Lapidoth, A Foundation in Digital Communications, Cambridge University Press, 2009*

Reference Books:

1. *Carlson A. and Paul Crilly, Communication Systems, 5th Edition. McGraw hill International, 2009.*
2. *Simon Haykin, Digital Communications, John Wiley & Sons, 2000*

EC6102 TELECOMMUNICATION SWITCHING & NETWORK PROTOCOL Cr.3

Introduction

Evolution of Telecommunication, Switching system, Classification of switching, Types of telephone switching systems, Elements of telecommunication, Telecommunication standard. **3 Hrs**

Telephone system

PSTN, Modern telecom system, telephone network, Telephone set. Telephone network organization. Principles and examples of step by step, Cross bar and reed relay systems, Telephone numbering plan, Central Battery System, Transmission impairments, Two/four wire transmission, Subscriber Loop Design. **4 Hrs**

Telecommunication Traffic

Telecommunication traffic, Traffic considerations, Erlang, Grade of service, traffic measurement, mathematical model for telecommunication traffic. **4 Hrs**

Switching systems

Resource sharing and need for switching – Need for networks, switching, types of switching, circuit switching, message/packet switching, store and forward switching, functions of switching system, electronic switching system, multiplexing, TDM (E1/E2, T1), FDM, implementation of switching system, blocking and non-blocking switches, single and multi stage switches, space switching, time switching, hybrid switching, path finding, complexity, blocking probability of switch. **12 Hrs**

Telephone Exchange
stored program controlled exchange, electronic exchange. Electronic switching and stored program control systems, Digital switching time, space and hybrid switches, Example of digital exchanges. Example of modern exchange(C-DOT exchange), availability of parallel exchange **6 Hrs**

Signalling Systems
Signalling, Types of signalling information, Forms of signalling, channel associated signalling(CAS),common channel signalling, CCITT No-7 system, SS7 signalling Architecture Computer and data networks, ARPANET, ALOHA – loke protocols Network topology. Multiple access schemes. Layered architectures. Networks Protocols. Local Area network. Evolution towards ISDN**.** **7 Hrs**

Text Books:
1. *Telecommunication and Switching, Traffic and Networks, J.E. Flood, Pearson Education, 2001.*
2. *Telecommunication Switching Systems and networks, ThiagarajanViswanathan, PHI, 2006.*

Reference Books:
1. *Signalling in Telecommunication Networks-john G. van Bose and fabrizio u devetak, wiley interscience, 2nd edition,2007*

EC6103 INFORMATION THEORY AND CODING TECHNIQUES Cr – 4

Information & Entropy: Introduction to information theory, self information, mutual information, conditional self information, average mutual information. Entropy & information, conditional entropy, properties of binary entropy function. **4 Hrs**

Source Coding: Analog source, Digital sources, Discrete Memoryless Sources. Noiseless coding, entropy coding, instantaneous codes, code efficiency & redundancy, information rate, source coding theorem, VLC, FLC, prefix codes, Kraft inequality, Shannon-Fano algorithm, Huffman coding algorithm, Lempel-Ziv algorithm, Run length encoding, Shannon's first and second fundamental theorems, extension of zero-memory sources, Markov sources and extension of Markov sources. **10 Hrs**

Channel Capacity & Coding: Discrete Memoryless channel, hard decision decoding and soft decision decoding, discrete channel with discrete noise, channel capacity and channel efficiency, channel matrix, binary symmetric channel (BSC), binary erase channel (BEC), lossless channel, deterministic channel, noiseless channel. Channel coding theorem, critical rate, information capacity theorem (channel capacity theorem), the Shannon limit. **10 Hrs**

Channel Coding (Error Control Coding)-I: Introduction to error correcting codes, definitions of word, codeword, code, weight, distance, Galois field, vectors, matrices, generator matrix. FEC & ARQ. Linear code and linear block code, theorems of linear block code, code rate, matrix description of linear block codes, parity check matrix, systematic code, decoding of linear block codes, a standard array, syndrome decoding, error probability after coding. Hadamard codes and Hamming codes, optimal linear codes, maximum distance separable codes, Hamming bound and perfect code, binary Golay code. **14 Hrs**

Channel Coding (Error Control Coding)-II: Binary cyclic codes, method of generating cyclic codes, burst error correction, Fire codes, circuit implementation of cyclic codes, cyclic redundancy check (CRC) codes, Meggitt decoder. Primitive element & minimal polynomial, Bose-Chaudhuri-Hocquenghem (BCH) codes, generator polynomial for BCH code, examples of BCH codes, Reed-Solomon codes, nested codes. Convolutional codes, tree codes & trellis codes, polynomial description of convolutional codes, Viterbi decoding of convolutional codes. **10 Hrs**

Text Books:
1. *Information Theory, Coding and Cryptography – R. Bose, 2nd Edition, Tata McGraw Hill.*
2. *Elements of Information Theory - T. M. Cover & J. A. Thomas, 2nd edition, Wiley & Sons*

Reference Books:
1. *Digital Communication – J. G. Proakis, 4th Edition, Tata McGraw Hill*
2. *Principles of Digital Communication – J. Das, S. K. Mullick& P. K. Chatterjee, 2011.*

EC6104 OPTICAL COMMUNICATION SYTEMS CR -4

Introduction: FM Frequency Spectrum, Optical Frequencies, Principle of Light Propagation in a fiber, Advantages of optical fiber communication, Fibre optic communication systems, Fibre optic components and cables, Materials used for fabrication of optical fiber, Light wave communication and computer networks, High bit-rate electronics, integrated optic. **2 Hrs**

Wave Propagation in optical fiber:
Relation between refractive index and velocity of light, Basic structure and ray diagram of optical path in an optical fiber, Acceptance cone, Numerical aperture, Concept of modes, Qualitative analysis of EM wave propagation in cylindrical waveguide, Different types of mode in optical fibers, Cut-off condition for guided modes, Boundary conditions, single mode/ multi mode fiber, Concept of V number and its importance. **8 Hrs**

Losses in fiber: Attenuation, pulse spreading, Intrinsic/ Extrinsic losses, Material or impurity losses, Rayleigh scattering loss, Absorption loss, Bending loss, Leaky modes, Core and cladding loss, Concept of dispersion, Intermodal dispersion, Intramodal dispersion, Wave guide and material dispersion, Minimization of dispersion. **7 Hrs**

Optical Sources: Light sources – principles, Technology, characteristics and modulation ,Short and long wave lengths, Characteristics of a good optical source, Principle of operation of LED, Types of LED structure and spectral characteristics, Principle of operation of laser diode, Laser structure, Comparison of LED/ Laser. **8 Hrs**

Modulation: Intensity modulation using both LED and Laser diode, LED Analog & Digital modulation, Laser Analog & Digital modulation, Formats of modulation, Pulse code modulation. **5 Hrs**

Optical detectors: Photodetectors – Principles, technology, parameters and characteristics, Principle of operation of PIN diode, Structure, Current characteristics, Principle of operation of APD, Structure, Current characteristics, Comparison of PIN/ APD, Receiver amplifiers, Noises at optical receiver, Thermal noise, Shot noise, SNR and Noise equivalent power. **7 Hrs**

Fiber link: Optical link budget, Power budget, Rise time budget, Design of components. Concept of WDM, Passive components used in WDM, Types of WDM techniques. **3 Hrs**

Measurement on Fibers: Measurement of Numerical Aperture and its related terms, Measurement of fiber attenuation, Optical time domain reflectometer, Loss measurement of each mode scattering losses measurement, Measurement of dispersion losses, Measurement of refractive index cut-off wavelength measurement. **5 Hrs**

Connectors and Splices:
Various types of connectors used for optical fiber, Splicing of fiber, Electric arch fusion splicing, Mechanical splicing, Steps involved in splicing, Losses in splices and connectors. **3 Hrs**

Text Books

1. *Optical Fiber Communication Systems, Gerd Keiser, Tata Mc-Graw hill, 2008.*
2. *Fiber Optic Communications, J. C. Palais, Pearson Education, 2005.*

Reference Books:

1. *Optical Fibers and Fiber Optic Communication Systems, Subir K Sarkar, S.Chand, 2007.*
2. *Optical Fiber Communications, John M Senior, Pearson Education, 3rd Edition.*
3. *Fiber Optics and Optoelectronics, R. P. Khare, Oxford, 1st Edition.*

EC6105 ADVANCED WIRELESS & MOBILE COMMUNICATION SYSTEMS Cr – 4

Overview of Cellular concept
Introduction to Cellular Communications, Frequency reuse, Multiple Access Technologies, Cellular Processes - Call Setup, Handover etc., Capacity improvement techniques, Teletraffic Theory **6 Hrs**

RF Propagation & Multi-path Model
Free space propagation model, propagation mechanism, Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss, Small Scale Fading, Doppler and time-delay spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading. **8 Hrs**

Over view of Modulation Techniques
Overview of QPSK, Offset QPSK, π/4 QPSK, MSK, GMSK, QAM **4 Hrs**

Equalization and Diversity Techniques
Fundamentals of Equalization, Adaptive equalizer, Concept of diversity, Types of diversity (space, time, frequency, polarization) **6 Hrs**

Spread Spectrum modulation and CDMA
Spread Spectrum Modulation principle and types, PN sequence and its properties. Introduction to CDMA, Walsh codes, Variable tree OVSF, Multipath diversity, RAKE Receiver, CDMA Receiver Synchronization. **6 Hrs**

OFDM and Multicarrier Modulation
Introduction to OFDM, Multicarrier Modulation and Cyclic Prefix,Channel model and SNR performance, OFDM Issues – PAPR,Frequency and Timing Offset Issues. **4 Hrs**

Multiple Antennas and space time communications
Introduction to MIMO, MIMO Channel Capacity, SVD and Eigenmodes of the MIMO Channel, MIMO Spatial Multiplexing – BLAST,MIMO Diversity – Alamouti, OSTBC, MRT,MIMO - OFDM **6 Hrs**

UWB (Ultrawide Band) Communication
UWB Definition and Features ,UWB Wireless Channels, UWB Data Modulation, Uniform Pulse Train,Bit-Error Rate Performance of UWB **4 Hrs**

Wireless Standards (3G and 4G)
GSM,GPRS,WCDMA,LTE,WiMAX **4 Hrs**

Text Books:
1. *Wireless Communication – T.S. Rappaport – Pearson Education, 2003.*
2. *Wireless Communication – Andrea Goldsmith – Cambridge Press, 2005.*

Reference Books:
1. *Wireless and Cellular Communication – C. Y. Lee – McGraw Hill, 2006.*
2. *Mobile Communication – Schillar – Pearson Education, 2008.*
3. *Communication System – Simon Haykin – John Willey, 2006.*

EC6106 ADVANCED DIGITAL SIGNAL PROCESSING Cr-4

Introduction:
Fundamentals Frequency domain analysis and Fourier Transform, Basic Filters, Ideal Filer Characteristics, Characteristics of Practical Frequency selective Filters, Fundamentals of FIR and IIR Filters , Structural Realization of FIR & IIR Filters. **5 Hrs**

Multirate Digital Signal Processing
Review of sampling theory, Sampling rate conversion, Polyphase implementation of FIR filters for rate conversion, Multistage implementations, Applications of Multirate Signal Processing, Digital Filter Banks, Subband Coding Basics, Subband Decomposition and Two-Channel Perfect Reconstruction Quadrature Mirror Filter Bank, M-Channel Quadrature Mirror Filter Bank. **10 Hrs**

Wavelet and Short Time Fourier analysis
Fourier Transform : Its power and Limitations, Short Time Fourier Transform, The Gabor Transform, Continuous Wavelet Transform, Wavelet Transform Ideal Case -Perfect Reconstruction Filter Banks and wavelets, Recursive multi-resolution decomposition, Haar Wavelet, Daubechies Wavelet. **15 Hrs**

Adaptive Filtering
Wiener filtering. Optimum linear prediction. Levinson- Durbin algorithm. Prediction error filters. Adaptive filters. FIR adaptive LMS algorithm. Convergence of adaptive algorithms. Fast algorithms. Applications; Noise canceller, echo canceller and equalizer. Recursive least – squares algorithms. Matrix inversion lemma. Convergence analysis of the RLS algorithm. Kalman filtering. **10 Hrs**

Spectral Estimation
Review of the theory of random processes , Spectrum estimation. Estimation of autocorrelation. Periodogram method. Nonparametric methods. Parametric methods. **8 Hrs**

Text Books:
1. *Digital Signal Processing – J. G. Proakis& D. G. Manolakes, 4th edition – PHI*
2. *A Wavelet Tour of Signal Processing the Sparse Way, Stephane Mallat, , Elsevier, 2009*

Reference Books:
1. *Multirate Systems and Filter Banks, P. P. Vaidyanathan, Prentice-Hall, 1993.*
2. *Wavelets and Signal Processing, Hans-Georg Stark, Springer, 2005*
3. *Statistical Digital Signal Processing and Modeling, M. Hayes, Wiley, 1996.*
3. *Statistical and Adaptive Signal Processing, D.G.Manolakis V. K. Ingle, and S. M. Kogon, McGraw-Hill,2005*

EC6108 DIGITAL IMAGE PROCESSING Cr – 3

Introduction:
Historical Background of image processing, fundamental steps in image processing, elements of digital image processing systems. Digital image representation, Different image processing tasks-Image enhancement, Image restoration, Image compression and image analysis. **2 Hrs**

Digital Image Fundamentals:
Elements of visual perception, A simple image model, sampling and quantization, relationship between pixels, image geometry: translation, rotation, perspective transformation, camera model, camera calibration, stereo imaging Image representation and Modelling: Monochrome and color representation, color – ordinate systems, Monochrome and colour vision Model, sampling and Quantization – Rectangular and Nonrectangular grid sampling and interlacing. Optimum Lioyd – Max quantizer, Compandor design, Practical Limitations. **4 Hrs**

Image Transform:
Review of mathematical preliminaries: matrix theory results: Toeplitz and circulant matrices, orthogonality and unitary matrices, positive definiteness and quadratic forms, block matrices and Kronecker products, separable operators, introduction to image transforms, Image Transform: Two dimensional Orthogonal and unitary transforms, properties of unitary transforms, 2-D DFT,Basic Image, Kronecker products and dimensionality: Proportion Algorithm etc. for DFT, Walsh Transforms, Hadamard transform, Discrete Cosine Transform (DCT), Discrete Sine Transform (DST), Haar Transform, Slant Transform, Brief introduction to wavelet transform and Moultrie solution analysis, Karhunan-Lauve (K-L) Transform, SVD Transform **6 Hrs**

Image Enhancement:
Introduction spatial domain methods, frequency domain method, Enhancement by point operation/processing: Histogram equalization, spatial filtering: Low pass median, Sharpening filter, High boost filters, derivative filters, enhancement in frequency domain, Homomorphic filtering,Transform cooperation **5 Hrs**

Colour Image Processing:
RGB, CMY and YIQ colour models conversion from RGB to HIS and HIS to RGB. **2 Hrs**

Image Restoration:
Introduction, degradation model, algebraic approach to restoration, inverse filtering, Weiner filter, Filtering using least square restoration and constrained least squares restoration, Maximum Entropy Restoration, restoration in spatial domain. **4 Hrs**

Image Compression:
Introduction and motivation, fundamental concepts: Data redundancy (coding redundancy, interpixel redundancy and psycho visual redundancy), fidelity criteria, image compression models, elements of information theory, image compression techniques: pixel coding (PCM run length- coding, bit-plane coding), Predictive coding, Delta modulation, DPCM etc., Transform coding (Zonal coding, Thresholding, coding with different transforms), Other techniques such as vector quantization and hybrid coding. Image compression standards. **7 Hrs**

Morphological Image processing: Dilation and erosion, Opening and closing, some basic morphological algorithms. **3 Hrs**

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation. **3 Hrs**

Text Books:

1. *Digital Image Processing, R.C. Gonzalez and R.E. Woods, Prentice Hall, 2008.*
2. *Fundamental of Digital Image Processing, A.K.Jain, Prentice Hall, 1989.*

Reference Books:

1. *Digital Image Processing, S. Jayaram, S. Esakkirajan, T. Veerakumar, TMH, 2009.*

EC6112 COMMUNICATION AND NETWORK SECURITY Cr-3

Introduction: Cryptography, Watermarking, Steganography, Escrow & Crypt Analysis, ISO/OSI reference model & security, Security threatening attacks & actions, Reviews of mathematical foundations (Logarithms, Prime Number, GCD, Groups, Rings, Fields, Fermat's Theorem, Euler's Theorem, Exclusive-Or, Random Numbers). **10 Hrs**

Ciphers &Algorithm: Symmetric Ciphers, Asymmetric Ciphers systems, Elliptic Curve Crypto systems, RSA Algorithm. **9 Hrs**

Cryptographic Key distribution system: Key Distribution, Merkle's Puzzle Method, Shamir's Key Distribution Method, Digital Signature. **6 Hrs**

Communication Security layer classification: A synergistic security frame work, Firewalls & Gateways, Security Cross-portfolios, attacks and security in the internet, TACACS. **5 Hrs**

Network security: Wireless system: WLAN security, IEEE 802.11i robust security network and vulnerabilities, GSM Security, B3G/4G Security Concerns, Wimax Security, and Communication Satellite network security, Wireless Adhoc Network Security. **6 Hrs**

Text Books:

1. *Cryptography & Network Security by B A Forouzan and D Mukhopadhyay, Mc-Graw Hill, India, 2010.*
2. *Security of Information and Communication Network by S V. Kartalopoulos, Wiley-IEEE Press. 2009.*

Reference Books:

1. *Handbook of Information and Communication Security by Stavroulakis, Peter; Springer, 2010*
2. *Secure Broadcast communication in Wired and Wireless Communication. By Adrian Perrig& Doug Tygar, Kluwer Publication, 2002.*
3. *Modern Cryptography: Theory and Practice by W Mao, Pearson Education, India, 2003.*

EC6113 ARTIFICIAL NEURAL NETWORK AND FUZZY SYSTEMS Cr-3

Introduction: Neural network, models of neuron, network architecture, artificial intelligence versus neural networks. **2 Hrs**

Learning Processes and Perceptrons: Error-correction and memory-based learning, Hebbian learning, competitive and other types of learning. Learning curves and learning rate annealing techniques, single-layer perceptron, perceptron convergence theorem. Multilayer perceptron, back-propagation algorithm, heuristics for making back-propagation algorithm perform better, output representation and decision rule. **9 Hrs**

Artificial Neural Networks and Neurodynamics: Radial-basis function networks, interpolation problem, regularization network, generalized radial-basis function networks. Support vector mechanics. Neurodynamical systems, stability, neurodynamical models, Hopfield and related models. **9 Hrs**

Fuzzy Sets and Fuzzy Rules: Introduction to fuzzy logic, various parameters, set-theoretic operations, MF formulation, fuzzy union, intersection and complement. Extension principle and fuzzy relations, uzzy rules, fuzzy reasoning. **8 Hrs**

Fuzzy Models and Fuzzy Systems: Mamdani fuzzy models, Sugeno fuzzy models, Tsukamoto fuzzy models, example of various fuzzy systems, neuro-fuzzy system, adaptive neuro-fuzzy system. **8 Hrs**

Text Books:

1. *Neural Networks – A Comprehensive Foundation- S. Haykin, 2nd Ed., Pearson Education Asia, 1999.*
2. *Neural Network Design-M. T. Hagan, H. B. Demuth and M. Beale, Cengage Learning, 2011.*

Reference Books:

1. *Neuro-Fuzzy and Soft Computing – J. S. R. Jang, C. T. Sun and E. Mizutani, PHI/Pearson, 2004.*
2. *Fuzzy Logic with Engineering Applications- T. J. Ross, Wiley, 2004.*

EC6114 SPREAD SPECTRUM TECHNIQUES AND MULTIPLE ACCESS Cr-3

Spread Spectrum Techniques: Introduction, Basic communication problems, Pulse noise jamming, Low probability of detection, Signal structure secrecy, Direct sequence spread spectrum, Frequency hopping spread spectrum: Coherent slow frequency hopping spread spectrum, Non Coherent slow frequency hopping spread spectrum, Non coherent fast frequency hopping spread spectrum, Hybrid direct sequence and frequency hopping spread spectrum, Time hopping and Multicarrier Systems. **6 Hrs**

Spreading Sequences: Correlation functions, Binary linear feedback Shift register sequence for spread spectrum, Definitions, mathematical background and sequence generator fundamentals, Maximal length sequences, Gold Sequences. **5 Hrs**

Communicating through fading Channels: Performance of spread spectrum system in Jamming environments, Spread spectrum communication model, performance in jamming environment without coding. Fading Channels: statistical model of fading, Characterization of mobile radio channel, Requirement of diversity in fading channel. **7 Hrs**

Code acquisition and Tracking Loops: Introduction, Optimum tracking of wideband signal, Baseband delay-lock tracking loop, Non coherent delay lock tracking loop, Code tracking loop for frequency hop system. **7 Hrs**

Multiple Access-multi-user interferences and multi-user Detection: Multiuser systems and multiple access problems, FDMA, TDMA, Code division multiple access, Synchronous CDMA, Asynchronous CDMA, and Asynchronous CDMA in cellular networks. **7 Hrs**

Applications: Multicarrier CDMA, MC-DS-CDMA, Ultra-Wideband (UWB) systems, Mobile communications and wireless networks: CDMA digital cellular systems, Specific examples of CDMA digital cellular systems. **4 Hrs**

Text Books:

1. *Introduction to Spread Spectrum Communication, by Roger L. Peterson, Rodger E Ziemer and David E. Borth, Prentice hall 1995,ISBN:0024316237*
2. *Spread Spectrum and CDMA Principle and applications, by Valery P. Ipatov ,John wiley& sons,Ltd,ISBN:0470091789, 2005.*

Reference Books:

1. *Spread Spectrum Systems by R.C.Dixon, John wiley& sons,Ltd,ISBN:0471539427, 1984.*
2. *A. J. Viterbi, CDMA: Principle of Spread Spectrum Communication, Addison-Wesley ,1995,ISBN:0201633744*

EC6115 PROBABILITY AND STOCHASTIC PROCESSES Cr-3

Probability: Random variables, distribution and density functions, expectation, characteristic functions, probability spaces, joint probability, conditional probability and independence, conditional expectation. Sequences of random variables, convergence concepts, laws of large numbers, central limit theorem. **7 Hrs**

Random Vectors and Estimation: Random Vectors, Covariance characterization, Jointly Gaussian random variables, distribution and mass functions, Sampling theorem, Karhunen-Leeve expansion, Orthogonal increment processes, White noise integrals, Spectral representation. **7 Hrs**

Stochastic Processes: Concept of stochastic Processes, Classification, ensemble, Time averaging and Ergodicity. Methods of description, Stationarity, Covariance and Correlation coefficient, Auto-correction and Cross-Correlation functions. **7 Hrs**

Special Processes: Markov processes and queuing theory, Wiener process, Poisson processes, Gaussian Process. **6 Hrs**

Stochastic Processes and Linear Systems: Linear filtering of Stochastic Processes, AR, MA and ARMA Processes, Detection of known Signals. Mean Square Error Filtering/Estimation, Optimal Filters, Weiner Filter and Kalman Filter, Spectral Estimation, Estimating a random variable with a constant, stored data wiener filter, Real Time wiener filter. **9 Hrs**

Text Book:

1. *Probability, Random variables and Stochastic processes- A. Papoulis & S.U. Pillai, 2nd Ed., McGraw Hill, 1984.*

Reference Books:

1. *Random Signals – K. Sam Shanmugam & A. M. Breipohl, 1st Ed., Wiley, 1988.*
2. *Probability, Statistics, and Random Processes - Alberto Leon-Garcia, 3rd Edition, Pearson Prentice Hall, 2008.*

EC6122 SATELLITE COMMUNICATION SYSTEMS Cr – 3

Introduction:
Frequency spectrum for satellite communication, Types of orbits, Kepler's Laws of planetary motion, Orbital perturbations, Geostationary orbit, Satellite launching, General satellite communication, Block diagram uplink, Downlink frequencies, Types of modulation techniques used orbits, and altitude control Satellite launch vehicles – Arian, SLV space shuttle. **9 Hrs**

Losses/ Attenuation:
Signal loss on transmission through earth's atmosphere, Atmospheric losses, Ionospheric effects, Rain attenuation. Satellite link budget: Transmission losses, Interference, System noise temperature, Link power budget. **9 Hrs**

Satellite sub-systems:
Antenna sub-systems, Attitude and orbit control sub-system, Power sub-system, Communication sub-system, TTC&M sub-systems. **9 Hrs**

Satellite Application:
Satellite application in TV, Internet, Mobile telephony, Receive only home TV, Master Antenna TV, Low earth orbit satellite systems and uses. Multiple access techniques - FDMA, TDMA, SS-TDMA. Interference in FDMA systems. **9 Hrs**

Text Books:

1. *Satellite Communication, T.Pratt&C.W.Bostia, Wiley, 2003.*
2. *Satellite Communication, D.Roddy,McGrahill, 2006.*

Reference Books:

1. *Digital Satellite Communications,T.T.Ha, Tata McGrahill, 1990.*

PGEC6124 DIGITAL VOICES AND VIDEO COMMUNICATION Cr – 3

Digital speech communication: Digital TV communication; Characteristics of speech signals: characteristics of picture signals; Subjective and objective testing; Bit rates in speech and picture communication. **12 Hrs**

CCITT recommendations for speech digitization: HDTV, Low resolution TV and Video conferencing requirements; Time domain waveform coding of speech – PCM, DPCM, ADPCM, DM and sub band coding; frequency do mat and LPC vocoders. **9 Hrs**

Coding of monochrome and color video signals: Transform and adaptive transform coding; sub band coding; vector quantization; Inter frame and Hybrid coding; Delayed decision and run length coding; Effects of transmission errors; Audio and Video conferencing; Video telephone. **15 Hrs**

Text Books:

1. Digital Coding of Waveforms - Principles and Applications to Speech and Video, Jayant N. S. and K. Knoll PHI - 1984
2. Digital Speech - Coding for Low Bit Rate Communication Systems A. M. Kondoz, Jhon Wiley & Sons - Apr. 1999

Reference Books:

1. Techniques& Standards for Image - Video and Audio Coding, K.R. Rao & J.J. Hwang PHI 1996

EC6126 MICROWAVE COMMUNICATION SYSTEMS Cr – 3

Introduction: Transmission trends, digital telephony, data and Video techniques, services and hierarchies, Microwave link, digital microwave system configurations. **6 Hrs**

Signal: Noise bandwidth of radio receivers, auto correlation and power spectral density function. Principles of PAM baseband transmission technique, P (E) performance of M – Level PAM and Generalized DUO – BINARY base band systems, Principles of PSK systems, M – ARY PSK, Quadrature partial response and ARK Systems. **6 Hrs**

Microwave amplifier: Microwave amplification devices (Solid state), Power amplifier performance, parametric amplifier. IMPATT and TRAPATT & TE devices. Reliability objectives for communication systems, System gain – the concept and applications, Multi path Fading, Frequency selective fading, Effect of co-channel interference and gain of digital systems, M-ARY, PSK and QAM microwave systems, Radio system performance design guidelines. **12 Hrs**

Correlative techniques and applications to digital radio system: Error detection in correlative systems, coding and modulation in correlative systems. Digital microwave system design: FCC regulation & CCIR recommendation related to digital radio system design, diversity and protection switching technique. **6 Hrs**

Systems: Radar transmitter and receiver, phased array scanning, typical microwave antennas and passive microwave components, micro strip antennas. Research and development trends and unresolved (hybrid DOV, DIV, DAV & DAVID Systems) problems. **6 Hrs**

Text Books:

1. *Microwave Devices and Circuits, S.Y.Liao,PHI, 1996.*
2. *MicrowaveEngineering,D.M.Pozar,John Wiley &Sons.Inc, 2011.*

Reference Books:

1. *Microwaves,K.C.Gupta,Wiley Eastern Limited, 1983.*
2. *Communication Systems, Simon Haykins, John Wiley, 2006.*

EC6128 WIRELESS SENSOR NETWORK Cr-3

Introduction: Basic Concepts, Platforms, Standardization, architecture and protocols, Applications in military, environment, healthcare, industry and energy, factors influencing WSN Design. **6 Hrs**

Physical & MAC Layer: PHY layer standard (IEEE 802.15.4), MAC challenges, MAC protocols for Sensor Network - Contention based (S-MAC, B-MAC, CC-MAC), reservation based-(TRAMA) & Hybrid MAC (Zebra MAC). **9 Hrs**

Network & Transport layer: Routing challenges, Data Centric and Flat- architecture protocol(SPIN), Hierarchical protocol (LEACH),Geographical routing protocol (MECN), Qos based Protocol(SAR).Challenges of Transport layer ,Transport Layer protocols (PSFQ & CODA). **9 Hrs**

Cross Layer Solutions: Interlayer Effects, Cross layer Interactions (MAC-Network, MAC-Application, Network and PHY, Transport –PHY), cross layer module. **3 Hrs**

Localization: Challenges in localization, Ranging Techniques, Range based Localization protocols, Range-Free Localization Protocol. **3 Hrs**

Time Synchronization: Challenges for Time synchronization, Timing Sync protocol for sensor network (TPSN), Time Diffusion Synchronization protocol (TDP), Rate based diffusion protocol (RDP). **6 Hrs**

Text Books:

1. *Ian F. Akyildiz and Mehmet Can Vuran, "Wireless Sensor Networks," Wiley, 2010*
2. *WaltenegusDargie and Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice,"Wiley, 2010.*

Reference Books:

1. *Jun Zheng and Abbas Jamalipour, "Wireless Sensor Networks: A Networking Perspective," Wiley, 2009*
2. *C. Raghavendra, K. Sivalingam& T. Znati, "Wireless Sensor Network", Springer, ISBN:1-4020-7883-8, August 2005.*

EC6132 MOBILTY MANAGEMENT CR-3

Introduction

Mobility management, necessity and requirement for wireless communication. **2 Hrs**

Mobility

Background, Mobility management functions, Mobility Management Techniques, Profile Replicatio, Related Work, Various mobility models, Summary and problems. **10 Hrs**

Off-Line Replication

Related Work, Optimization Objectives, Replication for Unicast Replica Update (UR), Replication for Multicast Replica Update (MR), Comparison between UR and MR, Summary and problems. **9 Hrs**

On-Line Replication

Related Work, Edge Algorithms, Tree Algorithms, Implementation Issues, Summary and problems. **8 Hrs**

Computer Simulations

Simulation Environment, Off-Line Replication, On-Line Replication, Summary and problems. **7 Hrs**

Text Books:

1. *Mobility Management in Wireless Networks Data Replication Strategies and Applications, Tian, Karen Q., Cox, Donald C –Springer 2004.*

Reference Books:

1. *Mobile computing-Rajkamal-Oxford Univ. Press*, 2007.

SCHOOL OF ELECTRONICS ENGINEERING

SPECIALIZATION: VLSI DESIGN & EMBEDDED SYSTEMS

EC6201 DIGITAL VLSI CIRCUITS Cr-4

Issues of Digital IC Design : General overview of design hierarchy, layers of abstraction, integration density and Moore's law, VLSI design styles, packaging styles, design automation principles; Challenges: power, timing, area, noise, testability reliability and yield. **5 Hrs**

Basic Circuit Concepts : Introduction to MOS transistor theory, sheet resistance and area capacitances of layers, driving propagation delay models of cascaded pass transistors, wiring capacitances; **7 Hrs**
Stick diagram and layout design, design rules; transistor scaling: constant field scaling, constant voltage scaling. **5 Hrs**

The CMOS inverter: VTC, switching behavior, noise margins, power dissipation, analytical delay model. Analysis of other inverters: resistive load inverter, saturated load NMOS inverter and others. Design of inverter, large capacitive loads and super-buffers. **8 Hrs**

Static CMOS Logic: complex CMOS logic gates, transistor sizing in static CMOS logic, ratioed logic-pseudo-nmos; logical effort: delay estimation and delay minimization, pass transistor logic, transmission gates. **10 hrs**

Dynamic CMOS design: steady-state behavior of dynamic gate circuits, noise considerations in dynamic design, charge leakage, charge sharing, cascading dynamic gates, domino logic, np-CMOS logic, problems in single-phase clocking, two-phase non-overlapping clocking scheme. **6 Hrs**

Different logic families like CPL, DCVSL etc. Sequential CMOS Logic Circuits. **3 Hrs**
Dynamic Random Access Memories (DRAM), Static RAM, non-volatile memories, flash memories, low-power memory. **4 Hrs**

Text Books:

1. *CMOS Digital Integrated Circuits, Sung-Mo Kang and Yusuf Leblebici, 3rd edition, TMH,2003*
2. *Digital Integrated Circuits: A Design Perspective, J. M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd Edition, PHI,2011*

Reference Books:

1. *CMOS VLSI Design: A circuits and Systems Perspective, West, Harris and Banerjee, 3rd edition, Pearson Education, 2012 .*
2. *Introduction to VLSI Circuit and Systems, John. P. Uyemura, 4th Reprint, Wiley India, 2011.*
3. *Essentials of VLSI Circuits and Systems, Eshraghian, Puckness and Eshraghian, 2/e, Pearson Education*
4. *Modern VLSI Design: System-on-Chip Design, Wayne Wolfe, 3rd ed, Pearson Education,2005.*
5. *Modern VLSI Design: IP-Based Design, Wayne Wolfe, 4/e, 2010, PHI.*

EC6202 EMBEDDED SYSTEM DESIGN Cr-4

Introduction: Introduction to embedded systems, Design standards, Characteristics of embedded systems, Peripherals and interfacing, System-on-Chip paradigm. **3 Hrs**

Modeling Techniques: Finite state machines models, Petri nets, Event nets, Data flow and Control flow models, Flow chart based models; Specification and representation of embedded systems: Behavioural and Structural hierarchy, Data driven and Control-driven concurrency, Communication and synchronization, Timing, Hardware design languages, Verilog, VHDL, System C, State Charts. **10 Hrs**

Hardware/Software Co-design: Hardware software partitioning and scheduling, Hardware and Software estimation models, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Reconfigurable computing, System-level power management, Trade-offs. **10 Hrs**

System-on-Chip and IP cores: Core based designs, On-chip networking. **3 Hrs**

Embedded processors: ARM, MIPS, PowerPC etc. along with their programming, FPGA, CPLD, DSP based controllers. **5 Hrs**

Embedded bus architecture: Bus architecture and transactions, serial interconnects, networked embedded systems; bus protocols, CAN bus. **5 Hrs**

Software for Embedded Systems: Time-critical IO handling, Embedded software design under size, performance, and reliability constraints, Software timing and functional validation, Programming methods and compilation for embeddable software, Real time operating systems, Device drivers; System level testing and reliability issues. **10 Hrs**

Case study of embedded system design tools and real-world embedded designs. **2 Hrs**

Text Books:

1. *Wayne Wolf, Computers as Components: Principles of Embedded Computing Systems Design, Morgan-Kaufmann, 2012.*
2. *Frank Vahid and Tony Givargis Embedded System Design: A Unified Hardware/Software Introduction, John Wiley, 2011.*

Reference Book:

1. *Embedded System Design, Peter Marwedel, 2009, Springer.*
2. *Embedded Systems, Raj Kamal, 2/e, 2011 TMH.*

EC6203 MOS DEVICE MODELING Cr-4

Review of semiconductor fundamentals: P- N junction characteristics, metal-semiconductor contacts, energy band diagram. **5 Hrs**

MOSFET Transistors: MOSFET structure, MOSFET operation, Threshold voltage, I-V characteristics, MOS capacitances, MOS Charge control model, Unified Charge Control Model, Simple Gradual Channel Approximation, Charge Control Model, Velocity saturation model, capacitance models, C-V characteristics – low and high frequency, AC small signal model. **12 Hrs**

Second order non-ideal effects: body effect, velocity saturation and mobility degradation, short-channel effects, narrow width effects, channel length modulation, charge sharing model. **10 Hrs**

Hot carrier effects, drain punchthrough, subthreshold operation, junction leakage, temperature effect, tunneling effect, gate tunneling, drain-induced barrier lowering (DIBL), gate-induced drain leakage (GIDL). **10 Hrs**

Noise modeling: noise sources in MOSFET, Flicker noise, thermal noise. **3 Hrs**

MOSFET Models: LEVEL 1, LEVEL 2, LEVEL 3, BSIM, EKV Models. **8 Hrs**

Text Books:

1. *MOSFET Modeling with SPICE : Principle and Practice; Daniel P. Forty; 1st ed, Pearson/PHI,1997*
2. *Device Electronics for Integrated Circuits; R. S. Muller and Kamins; 1st edition, John Wiley and Sons, 2010.*

Reference Books:

1. *Peration and Modeling of the MOS Transistor; Y. Tsividis; 2nd edition, MGH Publishers,1999*
2. *Solid State Electronic Devices; Streetman and Banerjee; 6th edition, 2013, PHI,*

EC6204 TESTING OF VLSI CIRCUITS Cr-4

Introduction to VLSI testing, test process and automatic test equipment, test economics and product quality, test economics. **3 Hrs**

Physical faults and their modeling, Fault equivalence and dominance; fault collapsing. Fault simulation: parallel, deductive and concurrent techniques; critical path tracing. **6 Hrs**

Testability measure: controllability and observability measure for both combinational and sequential circuits. **6 Hrs**

Test generation for combinational circuits: Boolean difference, D-algorithm, PODEM, etc. Exhaustive, random and weighted test pattern generation; aliasing and its effect on fault coverage. Test pattern generation for sequential circuits. **12 Hrs**

Design-for-Testability: ad-hoc and structures techniques, scan path and LSSD, Full, partial, Random-Access scan. Built-in self-test (BIST) techniques. **12 Hrs**

Memory Testing: permanent, intermittent and pattern-sensitive faults. **5 Hrs**

Boundary scan. Other advanced topics in testing. **4 Hrs**

Text Books:

1. *Essentials of Electronic Testing, M. L. Bushnell and V. D. Agrawal, 1st edition, 2005 Springer.*
2. *, Digital Systems Testing and Testable Design, M. Abramovici, M. A. Breuer and A. D. Friedman 2011, Jaico Publishing House*.

Reference Books:

1. *Testing of Digital Systems, N. K. Jha and S. Gupta, 1st edition 2003 Cambridge University Press.*
2. *VLSI Test Principles and Architectures; Wang, Wu and Wen; 2011, Morgan Kaufman, (Elsevier).*
3. *Built-in Test for VLSI: Pseudorandom Techniques, P. H. Bardell, W. H. McAnney and J. Savir, 1/e, 1987 John Wiley & Sons.*
4. *Fault Tolerant and Fault Testable Hardware Design, P. K. Lala, 2011, BSP publishers.*
5. *Delay Fault Testing for VLSI Circuits, A. Krstic and K-T Cheng, 1998, Springer.*
6. *Analog and Mixed Signal Boundary Scan, A. Osseiran (Ed.),1999 Springer.*

EC6205 DIGITAL SYSTEM DESIGN Cr-4

From specification to silicon. Abstraction levels in VLSI design, hardware description language, Design flow for HDL-based ASICs and FPGA. **3 Hrs**

Introduction to Verilog HDL, different levels of modeling, basic concepts, Verilog primitives, keywords, operators, data types, Verilog modules and ports; Structural modeling: gate type, design hierarchy, gate delay, propagation delay, logic simulation, design verification and testing, testbench writing; Dataflow-level modeling: continuous assignments, operators and operands, operator types, examples; Behavioral modeling. **15 Hrs**

Introduction to VHDL; Examples of design using VHDL. **2 Hrs**

Synthesis of combinational and sequential logic: logic synthesis, RTL synthesis, high-level synthesis, synthesis design flow, synthesis of combinational logic example magnitude comparator, etc; synthesis of sequential logic, synthesis of state machine: registers, counters, sequence detector, vending machines, traffic light controller; design partitioning; Basic concepts of high-level synthesis: partitioning, scheduling, allocation and binding. Technology mapping and Static Timing Analysis. **15 Hrs**

Logic Design: switch logic, gate restoring logic, Programmable Logic Array (PLAs), Finite State Machine (FSM), Gate array approach, CPLD, FPGA, standard cell approach. Counter architecture, ALU architecture, latches and flip-flops. **10 Hrs**

Case Study Design Example: instructor may choose any suitable digital system such as UART, A RISC Processor, etc. **3 Hrs**

Text Books:

1. *Verilog HDL: A Guide to Digital Design and Synthesis; Samir Palnitkar; 2nd edition, Pearson Education, 2011.*
2. *Verilog Digital System Design; Zainalabedin Navabi; 2nd edition, TMH,2012.*

Reference Books:

1. *Principles of Digital System Design using VHDL; C. H. Roth; Cengage Learning, 2011.*
2. *Advanced Digital Design with the Verilog HDL; Michael D. Ciletti; 2009,1st edition, PHI,2010*
3. *Circuit Design and Simulation with VHDL; V. A. Pedroni; 2nd edition, PHI,2011.*
4. *A VHDL Primer; J. Bhasker; 3rd edition, Pearson ,2002.*
5. *Verilog HDL Synthesis: A Practical Primer; J. Bhasker;, BSP Publishers, 2008.*
6. *FPGA-Based System Design, Wayne Wolf, 1st edition, Pearson.*

EC6207 ANALOG CMOS VLSI CIRCUITS Cr-4

Introduction: Analog circuits in VLSI, Overview of circuit performance comparison in Bipolar, BiCMOS and CMOS technologies. Review of MOS transistor theory, large signal and small signal models of MOS transistors, Feedback topologies and Stability theory. **8 Hrs**

Amplifiers: Basic amplifier topologies and their characteristics, common-source stage amplifier, Cascode amplifiers, Basic differential pair, Differential amplifier with active load; Two-stage differential amplifier: Analysis for different performance parameters, miller effect, types of noise, noise in single-stage amplifiers and differential pairs, Pole-zero compensation and Design. **15 Hrs**

Biasing circuits: Basic and cascode current mirrors, Current and Voltage references; bandgap reference, Folded cascode amplifier. **7 Hrs**

Operational amplifier: design of CMOS op-amp, one-stage op-amp, two-stage op-amp, cascade op-amp, performance parameters and analysis, compensation of op-amps. **10 Hrs**

Comparator: Simple comparator, Switch-based comparator, Latch-based comparator. **5 Hrs**

Oscillator: Ring oscillator, LC oscillator, Voltage control oscillator. **3 Hrs**

Test Books:

1. *Design of Analog CMOS Integrated Circuits; Behad Razavi; 1st edition, TMH, 2007.*
2. *CMOS Analog Circuit Design; Allen and Holberg; International 2nd edition, Oxford,2007.*

Reference Books:

1. *VLSI Design Techniques for Analog and Digital Circuits; Geiger, Allen and Strader; 1st edition,TMH,2010.*
2. *Analog Integrated Circuit Design; D.A. Johns and K. Martin; 2/e, Wiley India,2013.*
3. *Analysis and Design of Analog Integrated Circuits; Gray and Meyer; 4th edition, Wiley,2010.*
4. *CMOS Circuit Design, Layout and Simulation; Baker, Li and Boyce; Indian edition, 1st edition, PHI,2002*

EC6211 VLSI TECHNOLOGY Cr-3

Semiconductor review and survey of IC processing – Roadmap; Silicon crystal growth and wafer preparation; Unit Processes: Substrate cleaning, Oxidation; High k and low k dielectrics. **6 Hrs**

Doping techniques: Diffusion, Ion implementation; Pattern transfer: mask making & different lithography techniques (optical, x-ray, E-Beam, Ion-Beam and latest techniques); **10 Hrs**

Vacuum science & plasmas; Etching: wet and dry etching techniques, Isotropy, anisotropy, selectivity, wet plasma, RIBE etc.; annealing techniques. **6 Hrs**

Thin films: Physical deposition, evaporation and sputtering; Chemical Vapor Deposition techniques; Epitaxial growth; **6 Hrs**

Process integration: Device isolation technology (junction, dielectric, LOCOS, trench etc); self-aligned process, Resistors and Capacitors, Advances in Bipolar, MOS and BICMOS process technologies; SOI Devices. **6 Hrs**

A case study using process simulation tools. **2 Hrs**

Text Books:

1. *VLSI Technology, C.Y. Chang and S.M.Sze (Ed), McGraw Hill Companies Inc, 1996.*
2. *VLSI Fabrication Principles, S.K. Ghandhi, 2nd edition John Wiley Inc., New York, 2012.*

Reference Books:

1. *VLSI Technology,* S.*M. Sze (Ed), 2nd Edition, McGraw Hill, 2011.*
2. *"Principles of Microelectronics Technology", D.Nagchoudhari, Wheeler (India), 1998*
3. *Silicon VLSI Technology, Foundamentals, Practices & Modeling by P. B. Griffin, 1/e, Pearson Education, 2000.*
4. *The Science and Engineeringof Microelectronic Fabrication, Stephan A. Campbell, 2/e, Oxford*, 2001.

EC6215 MICROCONTROLLER BASED DESIGN Cr-3

General Microcontrollers: Introduction to the 8051 & 8052 microcontrollers, features, architecture, memory organization, addressing modes, instruction set, assembly programming, software development tools, parallel I/O ports, interrupts, timers/counters, serial communication, data and control transfer operations, serial data transmissions, programming and interfacing using 8051. Overview of Atmel microcontrollers. **8 Hrs**

PIC Microcontrollers: An introduction to PIC microcontrollers, PIC 8 Series and PIC 16 series microcontrollers and PIC family of microcontrollers, architecture, instruction set, programming using assembly and C languages of the PIC microcontrollers, interfacing PIC Microcontroller to other devices, applications of PIC microcontrollers. **8 Hrs**

AVR Microcontrollers: Introduction AVR RISC microcontroller architecture, AVR instructions set, AVR hardware design issues, hardware and software interfacing with AVR, communications links for the AVR, AVR system development tools. **7 Hrs**

AVR Microcontrollers Family: Introduction to AVR family of microcontrollers, Introduction to ATMEGA8 and AT90S1200 microcontrollers, programming of ATMEGA8 using C and assembly languages, interfacing of ATMEGA8 to other modules. **6 Hrs**

Design using Microcontrollers: Design of embedded systems using at89c51 applications in the area of industrial control, robotics. Embedded design using PIC for applications in automated vehicles. Embedded system design using AVR for applications in mp3, MPEG decoder, etc. **7 Hrs**

Text Books:

1. *The 8051 Microcontroller and Embedded System using Assembly and C, 2/e, Muhammad Ali Mazidi, J. G. Mazidi and R. McKinlay, 2nd edition Pearson Education India, ,2011.*
2. *The 8051 Micro Controller – Ayala, 3rd edition, Cengage learning, 2012*

Reference Books:

1. *Designing with PIC Microcontrollers- John B. Peatman, 1st edition,2002*
2. *Embedded systems and robots projects using 8051 microcontroller, Subrata Ghoshal, Cengage learning, 2012*
3. *Microcontrollers: Theory and Applications, Ajay Deshmukh, 2nd edition, 2012, TMH*
4. *Programming and customizing the AVR Microcontroller, Dhananjay V. Gadre, 1st edition, 2012, TMH*

EC6222 MIXED SIGNAL IC DESIGN Cr-3

Introduction to Mixed-signal design; Data converters: Introduction and characterization of ADC and DAC. **2 Hrs**

Block diagram of SAR ADC, Design of SAR ADC, Working principle and architecture of a folding-and-interpolation ADC, Design of sample and hold amplifier, Design of folding amplifier and interpolation network. **5 Hrs**

Working principle, various architecture and design of different high speed ADCs (e.g. flash ADC, pipeline ADC and others) and high resolution ADCs (e.g. sigma-delta converters), Working principle and various architecture of different high speed and high resolution DAC. **8 Hrs**

Phase locked loop: Simple PLL, Building blocks in PLL, Locking characteristic of PLL and Design of PLL; non-ideal effects in PLLs, Charge-Pump. PLL based frequency synthesizer, Application and block diagram of a DLL, Design of a multiphase generator. **8 Hrs**

Switched-Capacitor Circuits: switched-capacitor amplifiers, switched-capacitor integrator. Filters: Continuous time filter, Low pass, high pass and band pass active filter, Design of switched-capacitor filter, Design of Gm-C filter, Design of decimation filter. **9 Hrs**

Implementation of system on a chip and the associated issue: Precautionary measure for integrating analog and digital modules within an IC, Signal integrity, floor planning and physical design of mixed signal IC design. **4 Hrs**

Text Books:

1. *CMOS mixed-signal circuit design by R. Jacob Baker, Wiley India, IEEE press, 1st edition, 2009.*
2. *Design of analog CMOS integrated circuits by Behzad Razavi, McGraw-Hill, 1st edition, 2011.*

Reference Books:

1. *CMOS circuit design, layout and simulation by R. Jacob Baker, second edition, IEEE press, Wiley India,2011.*
2. *CMOS Integrated ADCs and DACs by Rudy V. dePlassche, Springer, Indian edition, 2nd edition, 2007.*
3. *Electronic Filter Design Handbook by Arthur B. Williams, McGraw-Hill, 1981.*
4. *Design of analog filters by R. Schauman, Oxford university Press, 1st edition,2010*
5. *An introduction to mixed-signal IC test and measurement by M. Burns et al., Oxford university press, first Indian edition, 1st edition,2009.*

EC6224 LOW POWER VLSI DESIGN Cr-3

Basics of MOS circuits: MOS transistor structure and device modeling, MOS inverters, MOS combinational circuits - different logic families. **5 Hrs**

Sources of power dissipation in CMOS circuits: static power dissipation - diode leakage power, subthreshold leakage power, gate and other tunnel currents; dynamic power dissipation - short circuit power, switching power, gliching power; degrees of freedom, energy delay product, power delay product. **10 Hrs**

Supply voltage scaling approaches: technology Level - feature size scaling, threshold voltage scaling; logic level - gate sizing for voltage scaling; **4 Hrs**

Architecture level - parallelism and pipelining; algorithm level - transformations to exploit concurrency; dynamic voltage scaling. Switched capacitance minimization approaches: system level - power down, system partitioning. **8 Hrs**

algorithm level - concurrency, locality, regularity, data representation; architecture level - concurrency, signal correlation; logic level - gate sizing, logic styles; layout level - layout optimization; technology level - advanced packaging, SOI. **5 Hrs**

Leakage power minimization techniques: threshold voltage scaling: MTCMOS, VTCMOS and Multiple-Vt CMOS circuits; gate sizing. Low power memory design: ROM, SRAM (4T, 6T), DRAM. **4 Hrs**

Text Books:

1. *CMOS Digital Integrated Circuits, Sung-Mo Kang and Yusuf Leblebici, 3rd edition, TMH,2011*
2. *Digital Integrated Circuits: A Design Perspective, J. M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd Edition, PHI,2001*

Reference Books:

1. *CMOS VLSI Design: A circuits and Systems Perspective, West, Harris and Banerjee, 3rd edition, Pearson Education,.*
2. *Low Power VLSI CMOS Circuit Design, A. Bellamour, and M. I. Elmasri, Kluwer Academic Press, 1995.*
3. *Low Power Digital CMOS Design, Anantha P. Chandrakasan and Robert W. Brodersen, Kluwer Academic Publishers,2002.*
4. *Low-Power CMOS VLSI Design, Kaushik Roy and Sharat C. Prasad, Wiley-India, 2011.*
5. *Essentials of VLSI Circuits and Systems, Eshraghian, Puckness and Eshraghian, 2nd edition, Pearson Education,*

EC6226 ADVANCED DIGITAL VLSI DESIGN Cr-3

Design of arithmetic building blocks: High speed adders: Carry select adder, Manchester carry-chain, carry bypass adder, carry-save adder, Kogge-Stone adder and others. Multipliers: array multiplier, carry save multiplier, Wallace tree multiplier, Dada tree adder, Booth's multiplier and others; delay optimization of adders and multipliers, barrel and logarithmic shifters, area-time tradeoff, power consumption issues, Optimization for speed, low-power design, high-speed logic. **15 Hrs**

PLA, personality matrix of a PLA, PLA folding, extended personality matrix, multilevel minimization, multilevel synthesis, Weinberger array. **5 Hrs**

Design automation tools, partitioning: constructive and iterative partitioning, Karnighan-Lin algorithm, ratio-cut algorithm, placement, floor planning, pin assignments, global routing, Lee's algorithm, detailed routing, channel routing, clock and power routing, algorithms. **10 Hrs**

Clocking and interconnect issues, vias, crosstalk, system noise, complexity management, Signal integrity issues, High speed interconnects. Clock, clock skew, clock distribution and routing, clock buffering, gated clock and clock tree. Design of buffers and I/O Pad. Memory design. **6 Hrs**

Text Books:

1. *CMOS Digital Integrated Circuits, Sung-Mo Kang and Yusuf Leblebici, 3rd edition, TMH,2009*
2. *Digital Integrated Circuits: A Design Perspective, J. M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd Edition, PHI,2012*

Reference Books:

1. *CMOS VLSI Design: A circuits and Systems Perspective, West, Harris and Banerjee, 3rd edition, Pearson Education,2011.*
2. *Essentials of VLSI Circuits and Systems, Eshraghian, Puckness and Eshraghian, 2/e, Pearson Education,2009*
3. *VLSI Physical Design Automation: Theory and Practice, Sadiq Sait and Habib Youssef, 1/e,1995, TMH.*

EC6228 OPTIMIZATION TECHNIQUES AND SOFT COMPUTING APPLICATIONS Cr-3

Optimization: Optimal problem formulation, single variable optimization algorithms: exhaustive search method, golden section search method, Newton-Raphson method and other methods. Multivariable optimization algorithms: direct search methods, gradient-based methods and other methods. Constrained optimization. Local and global optimization. Single objective and multi-objective optimization. **10 Hrs**

Integer programming, Geometric programming, simulated annealing, **5 Hrs**

Evolutionary Computing and Swarm Intelligence : Genetic algorithm, particle swarm optimization, Bacterial Foraging Optimization and other biologically inspired algorithms. **6 Hrs**

Artificial Neural Network: Introduction, Typical applications of ANNs : Classification, Clustering, Vector Quantization, Pattern Recognition, Function Approximation, Forecasting, Control, Optimization; NN model, NN architecture, Single-layer networks; Perceptron-Linear separability, Training algorithm, Limitations; Multi-layer networks-Architecture, Back Propagation Algorithm (BTA) and other training algorithms, Applications. Feed-forward networks, Radial-Basis-Function (RBF) and adaptive NN. Introduction to fuzzy logic. **15 Hrs**

Text Books:

1. *Optimization for Engineering Design: Algorithms and Examples, Kalyanmoy Deb, 2nd edition PHI, 2012*
2. *Genetic Algorithms in search, Optimization and machine learning, D. E. Goldberg, Pearson, 2013.*

Reference Books:

1. *E. Bonabeau, M. Dorigo and G. Theraulaz, Swarm Intelligence : From natural to Artificial Systems, 1999.*
2. *R. C. Eberhart, Y. Sai and J. Kennedy, Swarm Intelligence, The Morgan Kaufmann Series in artificial Intelligence, 2001.*
3. *K. Mehrotra, C.K. Mohan and Sanjay Ranka, Elements of Artificial Neural Networks, MIT Press, 1997 - [Indian Reprint Penram International Publishing (India), 1997]*
4. *Simon Haykin, Neural Networks - A Comprehensive Foundation, Pearson, 2009.*
5. *Martin T. Hagan, Howard B. Demuth, Mark H. Beale; Neural Network Design; Thomson 2002*
6. *A Cichocki and R. Unbehauen, Neural Networks for Optimization and Signal Processing, John Wiley and Sons, 1993.*
7. *J. M. Zurada, Introduction to Artificial Neural Networks, (Indian edition) Jaico Publishers, Mumbai, 1st edition,1999.*

EC6236 MEMS DESIGN Cr-3

An introduction to MEMS; Evolution of microsensors & MEMS; Materials & microelectronic technologies for MEMS; fabrication process. **4 Hrs**

Micromachining – surface and bulk micromachining: basic process flow, release, stiction, material choices, residual stress, stringers and planarization, wet etch-based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS; **12 Hrs**

Micromachined microsensors : mechanical, inertial, thermal; Micromachined microactuators; Integrated smart sensors and MEMS; Interface electronics for MEMS; **10 Hrs**

Microsensors & MEMS applications; MEMS for RF applications (RF MEMS); MEMS for Biomedical applications (BioMEMS); Microfluidics & their applications; Bonding & packaging of MEMS; **10 Hrs**

Text Books:

1. Microsystem Design, Stephen D. Senturia, 2001.
2. Micromachined Transducers Sourcebook, Gregory T. Kovacs, 1998.

Reference Books:

1. VLSI Technology, S.M. Sze, 2nd ed., McGraw-Hill Publishing company, NY, 1988
2. VLSI Fabrication Principles – Silicon and Gallium Arsenide, Sorab K. Ghandhi, 2nd ed., John Wiley and Sons, Inc., NY, 1994.

EC6242 CAD FOR VLSI Cr-3

Vlsi Design Methodologies **6 Hrs**

Introduction to VLSI Design methodologies – GAJSKI Y-chart, VLSI Design automation tools , Review of Data structures and algorithms , Graph Theory and Computational Complexity ,general purpose methods for combinatorial optimization.

Design Rules for Physical Design **10 Hrs**

Design rules - problem formulation - placement and partitioning algorithms-Greedy Algorithms, Stochastic Search, Mathematical Programming, Dynamic Programming, Circuit representation - Placement algorithms – partitioning-Kernighan and Lin Algorithm, Fiduccia and Mattheyses Algorithm.

Floor Planning and Routing **6 Hrs**

Floor planning concepts - shape functions and floorplan sizing - Types of local routing problems - Area routing - channel routing - global routing - algorithms for global routing.

Timing Analysis **6 Hrs**

Timing analysis-static timing analysis, dynamic timing analysis. Delay models-unit delay model, fixed delay model.

Simulation and Modelling **8 Hrs**

Simulation - Gate-level modeling and simulation - Switch-level modeling and simulation, High level Synthesis ,Allocation assignment and scheduling - Simple scheduling algorithm

Text Book:

1. "Algorithms for VLSI Design Automation", S.H. Gerez, John Wiley & Sons,2002.

Reference Book:

1. "Algorithms for VLSI Physical Design Automation", N.A. Sherwani, Kluwer Academic Publishers, 2002

SCHOOL OF ELECTRONICS ENGINEERING

SPECIALIZATION: RF & MICROWAVE ENGINEEIRNG

MA6003 ADVANCED MATHEMATICS-I Cr – 4

Unit-I

Numerical Methods: **16 Hrs**

Newton- Raphson and Iterative methods for finding roots of a Non- linear equation, Cholesky LU-decomposition, Jacobi and Gauss - Seidel method for a system of linear equations, Numerical Differentiation. Gaussian Quadrature, Solution of first and second order differential equations using Euler, Modified Euler and Runge-Kutta methods. Finite difference methods, Numerical solution of Parabolic, Elliptic and Hyperbolic partial differential equations using finite difference approach.

Unit-II

Probability and Statistics: **16 Hrs**

Moments, Moment generating functions, Random Variable, Distribution, Some special distributions such as Binomial, Poisson, Negative Binomial, geometric, uniform, Normal, Exponential, and Log normal. Bivariate distributions, Correlation and Regression, Estimation, Standard error, Markov Chain, Discrete- Time Markov Chains, Classification of States and Chains, Continuous-Time Markov Chains, The Birth-Death process of Queuing, Consideration in Queuing Models, Basic Single- Server Model with constant rate Single Server with Limited Queue Length, Multiple Servers with an Unlimited Queue and other Queuing models.

Unit-III

Algebra: **10 Hrs**

Group, Symmetric group, Cyclic Group, Sub group, Cosets and Quotient Group, Lagrange's theorem, Ring, Integral domains, Field, Ideal, Module.

Unit-IV

Green's Function: **6 Hrs**

Green's Functions: Application to physical problems; Green's function by eigen function method; Solution of initial and boundary value problems.

Reference Books:

1. *Jain, Iyenger and Jain, Numerical methods for Scientific & Engineering Computation, 5th edition, New age International Publishers, 2012*
2. *William W. Hines, Douglas C. Montgomery, David M. Goldsman and Connie M. Borror, Probability and Statistics in Engineering, 4th edition, John Wiley & Sons, Inc., 2011*
3. *John E. Freund's, Mathematical Statistics with applications, 7th edition, Pearson Publication, 2011*
4. *I.N. Herstein, Topics in Algebra, 2nd edition, Willy Estern Ltd.*
5. *Dean G. Duffy, Green's Functions with Applications, CRC Press-2001*

EC6301 ADVANCED ELECTROMAGNETICS Cr - 4

Time-varying Electromagnetic Fields: Maxwell's equations, potential functions, retarded vector potential, Lorentz gauge condition. Electromagnetic boundary conditions, interface between a dielectric and a perfect conductor, Homogeneous and non-homogeneous Helmholtz's wave equations, principle of duality, plane waves in lossless and lossy media, Propagation of plane wave through ionized gases, plasma frequency, Phase velocity and group velocity, Flow of electromagnetic power and Poynting vector. **12Hrs**

Transmission Lines: Origins of primary transmission line parameters (R, L, C, G), characteristic impedance, phase constant, attenuation constant, distortionless line. Input impedance for a finite transmission line, transmission lines as circuit elements, transients on transmission lines, initially charged line, quarter-wave transformer, SWR. Smith chart, single-stub and double-stub matching. **10 Hrs**

Planar Transmission Lines: Strip line, microstrip line, slot line, Concept of effective dielectric constant. Design equations for strip line, microstrip line and slot line, Losses in microstrip line, Coplanar waveguide (CPW), Theory and design of planar coupled-line directional coupler. **10 Hrs**

Waveguides and Cavity Resonators: Waveguide structures and excitation of waveguides, TE and TM modes of propagation through rectangular waveguide and circular waveguide, power losses through waveguide, wave impedance, transmission line analogy of waveguide and circuit representation of waveguide, Rectangular and circular cavity resonators. **10 Hrs**

Propagation of Electromagnetic Waves through Anisotropic Media: Index ellipsoid, Plane-wave propagation through anisotropic crystals, Fresnel's equation of wave normal, plane-wave propagation through uniaxial crystals, double refraction. Permeability matrix for ferrites, TEM wave propagation through d. c. magnetized ferrites, Faraday effect. **6 Hrs**

Text Books:

1. *Field and Wave Electromagnetics – D. K. Cheng, 2nd Ed, Pearson Education, 2004.*
2. *Electromagnetic Waves and Radiating Systems – E. C. Jordan and K. G. Balmain, 4th Ed Pearson Education/PHI,., 2006.*

Reference Books:

1. *Field & Waves in Communication Electronics – S. Ramo, J. R. Whinnery and T. Van Duzer, 3rd Ed John Wiley & Sons., 1994.*
2. *Microwave Engineering- D. M. Pozar, 3rd Ed John Wiley & Sons, 2005*.

EC6302 RF CIRCUIT DESIGN Cr-4

Introduction: RF Behavior of Passive Components: High Frequency Resistors, High-Frequency Capacitors, High-Frequency Inductors. Chip Components and Circuit Board Considerations: Chip Resistors, Chip Capacitors, Surface-Mounted Inductors. **6 Hrs**

An Overview of RF Filter Design: Basic Resonator and Filter Configurations, Insertion Loss, Special Filter Realizations: Butterworth –Type, Chebyshev and Denormalization of Standard Low-Pass Design. Filter Implementations: Kuroda's identities and examples of microstrip filter design, Coupled filter design. **12 Hrs**

Matching and Biasing Network: Impedance matching using discrete components: two component matching networks. Microstrip line matching networks: from discrete components to microstrip lines, single-stub matching networks, double-stub matching networks, Amplifier Classes of Operation and Biasing Network, Field effect transistor biasing networks. **10 Hrs**

RF Transistor Amplifier Design: Amplifier Power Relations: RF source, Transducer Power Gain, Additional Power Relations, Stability Considerations: Stability Circles, Unconditional Stability, Stabilization Methods. Constant Gain: Unilateral Design, Unilateral Figure of Merit, Bilateral Design, Broadband, High Power and Multistage Amplifiers. **12 Hrs**

RF Oscillators and Mixers: Basic Oscillator Model: Negative resistance oscillator, Feedback oscillator design, Design steps, Quartz oscillators. High frequency oscillator Configuration: Fixed frequency oscillators, Dielectric resonator oscillators, YIG-Tuned oscillators, Voltage-controlled oscillators, Gunn oscillator, Characteristics of different types of Mixers. **8 Hrs**

Text Books:

1. *RF Circuit Design Theory and Application- R. Ludwig and P. Bretchko, 1st Ed, Pearson Education, 2009.*

Reference Books:

1. *Radio Frequency & Microwave Electronics Illustrated, M. Radmanesh, 1st Ed. Pearson Education, 2004.*

EC-6303 MICROWAVE DEVICES AND CIRCUITS Cr – 4

Microwave Solid State Devices: Basics of microwave BJT, microwave FET and microwave tunnel diode. Gunn effect, Gunn diode, Two-valley model theory, modes of operation (Gunn oscillation mode, LSA mode, SA mode), microwave generation and amplification using Gunn. READ diode, carrier current and external current in a READ diode resonant circuit, Working principle of IMPATT diode, Power output and efficiency of IMPATT circuit, TRAPATT diode and BARITT diode. **12 Hrs**

Microwave Tubes: Limitations of conventional vacuum tubes, Reentrant cavities, Klystron amplifier (velocity modulation, bunching process, power output, efficiency), Reflex Klystron (velocity modulation, bunching process, power output,

efficiency, electronic admittance spiral), Slow wave structure, helix TWT, BWO, Magnetron oscillator (Hull cut-off equations, strapping, frequency pulling & pushing, power output, efficiency). **14 Hrs**

Microwave Components: Scattering matrix formulation of microwave network, Tees, waveguide directional couplers (two-hole and Bathe-hole), rat-race ring, precision variable attenuator, coaxial attenuator, microwave phase shifters, waveguide slotted section, circulator, isolator, crystal detector **12Hrs**

Microwave Filters: Periodic structures and their analysis, filter design by image parameter method, constant k-filter and m-derived filter sections, filter design using insertion loss, filter transformations, design of stepped-impedance filters, coupled-line filters. **10 Hrs**

Text Books:

1. *Microwave Devices and Circuits- S. Y. Liao, 3rd Ed Pearson Education, 2013.*
2. *Microwave Engineering- D. M. Pozar, 3rd Ed, John Wiley & Sons, 2005.*

Reference Books:

1. *Microwave Engineering – G. S. Raghuvanshi, 1st Ed, CENGAGE Learning, 2012.*
2. *Microwaves-Introduction to Circuits, Devices & Antennas–M. L. Sisodia & V. L. Gupta, 1st Ed New Age International, 2004.*

EC6304 COMPUTATIONAL TECHNIQUES IN ELECTROMAGNETICS Cr-4

Introduction: Need for numerical solution of electromagnetic problems, selection of a numerical method, classification of electromagnetic problems, classification of solution region, classification of boundary conditions. **6 Hrs**

Integral Equation and Green's Function: Classification of integral equations, relation between differential and integral equations, overview of Green's function, Green's function for free space, Green's function with conducting boundaries (method of Images & Eigen function expansion). **10 Hrs**

Method of Moments: Overview, application to quasi-static problems (thin conducting wire, parallel plate capacitor), application of scattering from a short dipole, mutual impedance of two short dipoles, etc. **8 Hrs**

Finite Difference Methods: Overview, finite difference schemes, finite differencing of parabolic, hyperbolic & elliptical partial differential equation, practical applications of FD technique (guided structures). Finite Difference Time Domain Methods: Yee's FD algorithms, accuracy & stability, lattice truncation condition, initial fields, absorbing boundary conditions for FDTD, finite differencing for nonrectangular systems. **12 Hrs**

Finite Element Method: Finite element discretization, element governing equations, assembling of all elements, solving the resulting equations, typical applications. **6 Hrs**

Electromagnetic Diffraction: Geometrical theory of diffraction & its uniform theory of diffraction (UTD. **6 Hrs**

Text Books:

1. *Numerical Techniques in Electromagnetics- M. N. O. Sadiku, , 2nd Ed, CRC Press, 2001.*
2. *Analytical and Computational Methods in Electromagnetics–R. Garg, Artech House, 1st Ed., 2008.*

Reference Books:

1. *Numerical Techniques in Microwave and Millimeter wave Passive Structures - T. Itoh (Ed.), 1st Ed. John Wiley & Sons, 1989.*

EC6305 ANTENNA THEORY AND TECHNIQUES Cr – 4

Antenna Basics: Radiation mechanism, far field & near field, radiation pattern, E-plane & H-plane, radiation resistance, efficiency, effective aperture area, directivity, gain, beamwidth, bandwidth, linear & elliptic polarizations, cross polarization, antenna factor, antenna-noise temperature, equivalence theorem, Friis transmission formula. **6 Hrs**

Antennas: Dipole & monopole antennas, sleeve antenna. Waveguide antenna, pyramidal and conical horns, sectoral horns, Helical antenna and dielectric resonator antenna, Discone antenna, turnstile antenna, plasma antenna, Vivaldi antenna, electrically small antennas and their fundamental limits. **8 Hrs**

Broadband and Frequency-independent Antennas: Rumsay's principle, planar log-spiral antenna, log-periodic antenna, Yagi-Uda array. **5 Hrs**

Antenna Arrays: Uniform n-element linear array, grating lobes, planar antenna array, phased array antenna, adaptive antennas, Dolph-Tchebyscheff array, basic concept of thinned array antennas and methods of array thinning. **9 Hrs**

Reflector Antennas: Corner reflectors, parabolic reflector, losses in parabolic reflector, tilted and offset-fed parabolic reflector, Cassegrain antenna. **6 Hrs**

Microstrip Antennas: Advantages and disadvantages of microstrip patch antennas, radiation from microstrip antenna, field configurations, design equations for rectangular and circular microstrip patches. Analysis of microstrip antennas using transmission line model and cavity method, Stacked, proximity-coupled and aperture-coupled microstrip antennas, ceramic antenna, PIFA. **7 Hrs**

Special Antenna Techniques for Wireless Communications: Antenna Diversity Techniques, base station and mobile station antennas, Sector Antennas, Smart Antennas, MIMO antennas, SDMA Antennas, concept of UWB antennas. **7 Hrs**

Text Books:

1. *Antennas for All Applications-J. D. Kraus & R. J. Marhefka, 3rd Ed., Tata McGraw Hill, 2007.*
2. *Antenna Theory – Analysis and Design-C. A. Balanis, Harper & Row, 3rd Ed., 2005.*

Reference Books:

1. *Antennas and Radio Wave Propagation-R. E. Collin, 1st Ed., McGraw Hill, 1985.*

EC6311 MICROWAVE REMOTE SENSING Cr-3

Microwave Remote Sensing and Physical Fundamentals: Electromagnetic spectrum and penetration capabilities of electromagnetic wave through vegetarian, soil, moisture etc. energy and power of wave. Introduction to microwave remote sensing, microwave remote sensing from space, radios, death rays, principles of radar, phase as a distance measure, passive remote sensing and active remote sensing. **7 Hrs**

Polarimetry: Polarized wave and partially polarized wave, scattering matrix, passive polarimetry and Radar polarimetry, polarimetric ratio, coherent parameters and polarimetric decomposition. **5 Hrs**

Microwave in Remote Sensing: Microwave brightness temperature, interaction with discrete objects, radar cross-section, microwave scattering and emission from oceans, lakes, ice, snow, glacier, soil, vegetarian, rocks, deserts etc, detection of microwaves, microwave radiometer, antenna properties for microwave remote sensing, Dielectric properties of earth materials at microwave frequencies, atmospheric sounding. **9 Hrs**

Passive and Active Imaging: Principles of passive imaging, practical radiometers, and measurement of parameters related to ocean, sea, ice, land. Principles of active imaging using Radar, altimeter measurement, scanning altimeters, echo shape analysis, synthetic aperture altimeters, rain Radar, wind scatterometers, imaging Radar, principles of synthetic aperture radar (SAR), SAR focusing, scanSAR operation, spotlight mode, SAR images, speckle statistics and speckle filtering. **9 Hrs**

Interferometry: Principles of interferometry, phase measurements, interferometry for resolving direction, passive imaging interferometry, Radar interferometry, interferometric altimetry, interferometric SAR, vegetation height estimation. **(6 Hrs)**

Text Books:

1. *Introduction to Microwave Remote Sensing – I. H. Woodhouse, CRC Press/Taylor & Francis, 2006.*

Reference Books:

1. *Remote Sensing of Snow and Ice- G. Rees, CRC Press, Taylor & Francis, 2006*
2. *Fundamentals of Remote Sensing and Airphoto Interpretation - G. L.L. Berlin and T. E. Avery, Prentice Hall, NJ, USA, 2003.*

EC-6312 ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY Cr-3

Introduction to Electromagnetic Interference and Electromagnetic Compatibility: Electromagnetic interference & its analysis, types of noise & interference, electromagnetic compatibility, radiated emission & susceptibility, conducted emission & susceptibility, benefits of good EMC design, EMI/EMC standards and regulations. **4 Hrs**

EMC Requirements for Electronic Systems: Requirement for commercial products and military products, radiated emission limits for class A, class B, FCC and CISPR, measurement of emissions for verification of compliance: Radiated Emission and conducted emissions, product requirements, design constraints for products, advantages of EMC design. **5 Hrs**

Conducted Emission and Susceptibility: Measurement of conducted emission: LISN, common and differential mode currents, power supply filters: basic properties of filters, a generic power supply filter topology, effect of filter elements on common and differential mode currents, separation of conducted emissions into common and differential mode components for diagnostic purpose, power supplies: Linear and SMPS, effect of power supply components on conducted emissions, power supply and filter placement, conducted susceptibility. **8 Hrs**

Radiated Emission and Susceptibility: Simple emission models for wires and PCB lands: Differential mode versus common mode currents, differential mode current emission model, common mode current emission model, current probes, simple susceptibility models for wires and PCB lands: Shielded cables and surface transfer impedance, EMI measurement and EMI sensor. **5 Hrs**

Cross Talk: Three conductor transmission lines and crosstalk, Transmission line equations for lossless lines, line parameters, inductive-capacitive coupling approximation model: Frequency domain inductive-capacitive coupling model, time domain inductive-capacitive coupling model, lumped circuit approximate models. Shielded wires: Per unit length parameters, inductive and capacitive coupling, effect of shield grounding, effect of pigtails, effects of multiple shields, MTL model predictions, Twisted wires: Per unit length parameters, inductive and capacitive coupling, effects of twist, effects of balancing. **8 Hrs**

Shielding: Shielding effectiveness, far field sources: Exact solution, approximate solution, near field sources: near field versus far field, electric sources, magnetic sources, low frequency, magnetic fielding shielding, effect of apertures. **4 Hrs**

System Design for EMI/EMC and Other Related Issues: Shielding and grounding, PCB Design, electrostatic discharge, diagnostic tools. Signal integrity and its effect in PCB design. Annoying effect, distributing effect, biological effect of EMI. **2 Hrs**

Text Books:

1. *Introduction to Electromagnetic Compatibility-C. Paul, 2nd Ed., John Wiley & Sons, 2006.*
2. *Electromagnetic Compatibility Handbook – K. L. Kaiser, 2nd Ed., CRC Press Inc., 2005.*

Reference Books:

1. *Electronic Communications Systems- G. Kennedy, 4th Ed., McGraw-Hill, 2003.*
2. *Noise Reduction Techniques in Electronic Systems- H. W. Ott, 2nd Ed., John Wiley & Sons, 1976.*

EC6313 OPTIMIZATION TECHNIQUES IN ENGINEERING Cr - 3

Introduction: Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms. **4 Hrs**

Single-variable Optimization Algorithm: Optimality Criteria, Bracketing methods: Exhaustive search methods, Region-Elimination methods; Interval halving method, Fibonacci search method, Point estimation method; Successive quadratic estimation method. **6 Hrs**

Gradient-based Methods: Newton-Raphson method, Bisection method, Secant method, Computer programmes. **4 Hrs**

Multivariable Optimization Algorithm: Optimality criteria, unidirectional search, Direct search methods: Evolutionary optimization method, Simplex search method, Hooke-Jeeves pattern search method, Cauchy's (Steepest descent) method, Newton's method, multi-objective optimization, Pareto optimization. **6 Hrs**

Constrained Optimization Algorithm: Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, Convex method. **8 Hrs**

Advanced Optimization Algorithms: Genetic Algorithm (GA), working principles, GA operators, selection methods, advanced GAs, computer programmes, simulated annealing. Particle swarm optimization (PSO), differential evolution (DE) algorithm, bacterial foraging algorithm, ant colony optimization algorithm. **8 Hrs**

Text Books:

1. *Optimization for Engineering Design-Algorithms & Examples – K. Deb, PHI, 2nd Ed., 2012.*
2. *Multi-objective Optimization Using Evolutionary Algorithms-K. Deb, John Wiley & Sons, 1st Ed., 2001.*

Reference Book:

1. *Optimization: Theory and Applications - S.S. Rao, Wiley Eastern Ltd, 2nd Ed., 1979.*

EC6314 RADAR AND NAVIGATION ENGINEERING Cr – 3

Introduction to RADAR: Radar principle, Radar system losses & propagation losses, antennas, Radar cross section, Rayleigh region, Mie region, Optical region, Scanning & Tracking Radars, Radar clutter, SONAR & LIDAR, Synthetic aperture Radar (SAR). **6 Hrs**

RADAR Transmitters and Receivers: Principles of microwave power sources (qualitative) Radar modulators & Radar transmitters, Types of Radar receivers, receiver noise and noise figure, receiver protectors. **4 Hrs**

Types of Radar: Basic principles of CW Radar, FMCW & Gated CW Radars, Pulse Doppler Radar, MTI Radar. **6 Hrs**

Navigation Engineering: Methods of navigation (celestial navigation, pilotage and dead reckoning, radio navigation). Classes of radio direction finders, direction finding using loop antennas and errors in this method, Adcock direction finders, Goniometer, automatic direction finders, Radar Beacons, Hyperbolic electronic navigational systems (Decca, Consol, Omega & LORAN systems), Principles of distance measuring equipment (DME) and tactical air navigation (TACAN). **10 Hrs**

Aircraft Homing System and Landing System: Switched cardiod homing system, four course radio range, omnidirectional range, VHF omnirange (VOR), electrical pattern rotation, recovery of reference phase and measurement of bearing, Doppler VOR, Instrument landing system, elevation and azimuth guidance, localizer, Ground control approach, Radar altimeter, principle of precision approach radar (PAR) landing system, jamming & anti-jamming techniques. **10 Hrs**

Text Books:

1. *Introduction to Radar Systems - M.I. Skolnik, 3rd Ed., Tata McGraw Hill, 2003.*
2. *Radar Systems and Radio Aids to Navigation- A. K. Sen and A. B. Bhattacharya, Khanna Publishers, 1988.*

Reference Books:

1. *Fundamentals of RADAR, SONAR and Navigation Engineering (with Guidance) – K. K. Sharma, S. K. Kataria 1st Ed. Sons Publication, 2012.*

EC6316 MICROWAVE INTEGRATED CIRCUITS Cr-3

Introduction: Introduction to Microwave Integrated Circuits (MIC) and Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices in MIC and MMIC. **6 Hrs**

Planar Transmission Lines-I: Strip line & microstrip line, field configurations, quasi-TEM mode in microstrip line, analysis of microstrip transmission line, concept of effective dielectric constant, impedance of Strip line & microstrip line, dispersion and losses in microstrip line, discontinuities in microstrip. **8 Hrs**

Planar Transmission Lines-II: Slot Line, approximate analysis and field distribution of slot line, transverse resonance method and evaluation of slot line impedance, comparison with microstrip line. Fin lines & Coplanar Lines, analysis of Fin lines by transverse resonance method, conductor loss in Fin lines, coplanar wave guide (CPW). **10 Hrs**

Parallel-coupled Microstrip Lines and Power Dividers: Coupled microstrip lines, even mode and odd mode characteristic impedances, semi-empirical formulae for coupled line parameters, coupled-region length, coupler directivity, crosstalk between microstrip lines, design of microstrip branch-line power divider and rat-race ring power divider. **8 Hrs**

MIC Measurement, Testing and Applications: MIC measurement system, microwave test fixtures and probes, measurement techniques of S- parameters, noise measurement. **4 Hrs**

Text Books:

1. *Microstrip Lines and Slot Lines - K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia, 2nd Ed., Artech House, , 1996.*
2. *Foundation for Microstrip Circuit Design-T. C. Edwards, 2nd Ed., John Wiley & Sons Ltd, 1992.*

Reference Books:

1. *Stripline-like Transmission lines for Microwave Integrated Circuits, B. Bhat, S. K. Koul, 1st Ed., Wiley Eastern Ltd, 1989.*
2. *Microwave Integrated Circuits, K.C. Gupta and A. Singh, 1st Ed., Wiley Eastern Limited 1975.*

EC6318 RF MICRO-ELECTROMECHANICAL SYSTEMS Cr - 3

MEMS Fabrication Processes: Introduction**,** MEMS Overview, Microfabrication of MEMS: Surface Micromachining, Bulk Micromachining, LIGA, micromachining of polymeric MEMS devices, Three dimensional microfabrications. **4 Hrs**

MEMS Actuators and Sensors: Electromechanical transducers: Piezoelectric transducers, Electrostrictive transducers, Magnetostrictive transducers, Electrostatic actuators, Electromagnetic transducers, Electrodynamic transducers, Electrothermal actuators, comparison of electrothermal actuation process, Microsensing for MEMS: Piezoresistive sensing, Capacitive sensing, Piezoelectric sensing, Resonant sensing, Surface Acoustic Wave sensors. **7 Hrs**

MEMS Materials and Fabrication Techniques: Metals, semiconductors, thin films for MEMS and their deposition techniques, materials for polymer MEMS, Bulk micromachining for silicon based MEMS, Silicon surface micromachining, Microstereolithography for polymer MEMS. **5 Hrs**

MEMS Switches and Micro Relays: Switch parameters, basics of switching, Switches for RF and microwave applications, actuation mechanisms for MEMS devices, bistable micro relays and microactuators, dynamics of switch operation, MEMS switch design considerations, modeling and evaluation. **5 Hrs**

MEMS Inductors and Capacitors: MEMS Micromachined passive elements: pros and cons, MEMS Inductors: self and mutual inductance, micromachined inductors, reduction of stray capacitance, improvement of quality factor, folded inductors, modeling and design issues of planar inductors, variable inductor and polymer based inductor. MEMS Capacitors: MEMS gap tuning capacitor, MEMS area tuning capacitor, Dielectric Tunable capacitors. **9 Hrs**

MEMS Packaging and MEMS Applications: MEMS packaging: Role of MEMS packaging, Types of MEMS packaging, flip-chip and multichip module packaging, RF MEMS packaging issues, Micromachined transmission line and components, micromachied RF Filters, Micromachined Phase shifters & Micromachined antenna, Gyros and Bio-MEMS. **6 Hrs**

Text Books:

1. *RF MEMS: Theory, Design, and Technology-Gabriel M. Rebeiz, 1st Ed., John Wiley & Sons, 2003.*
2. *RF MEMS & Their Applications-V. K. Varadan, K. J. Vinoy and K. A. Jose, 1st Ed., John Wiley & Sons, 2003.*

Reference Books:

1. *MEMS and Microsystems: Design and Manufacture-Tai-Ran Hsu, 1st Ed., Tata McGraw-Hill, 2002.*

EC-6322 PLANAR AND SMALL ANTENNAS Cr - 3

Planar Radiators: Introduction to antennas (radiation pattern, directivity, efficiency, gain, impedance, axial ratio etc.), different types of planar antennas, applications of planar antennas, Brief description of fabrication process of planar antennas. **4 Hrs**

Microstrip Patch Antennas-I: Characteristics of microstrip patch antennas, radiation from microstrip antenna, field configurations, different types of feeding techniques. Design equations for rectangular and circular microstrip patches, analysis of microstrip antennas using transmission line model and cavity method. Broadband techniques using stacked patch antennas, proximity-coupled and aperture-coupled microstrip antennas, slot-loaded and slit-loaded microstrip antennas, microstrip antennas with shorted pin, effect of finite ground plane on the performance of microstrip antennas, principle of planar fractal antennas. **8 Hrs**

Microstrip Patch Antennas-II: Methods of generating circular polarization in microstrip antennas using single feed and double feed, methods of generating multiple frequencies using microstrip antennas, miniaturization techniques for mcirostrip antennas. Design techniques of microstrip antenna arrays with feed network, effect of mutual coupling, microstrip phased array antenna design. **8 Hrs**

Planar Slot Antennas: Geometry and design of microstrip slot antenna, radiation pattern, CPW-fed slot antennas, design of folded slot antenna, annular slot antenna. **4 Hrs**

Planar Monopole Antennas: Feeding methods and characteristics of planar triangle monopole, Sierpinski monopole, planar bi-conical monopole antenna and roll monopole antenna. **4 Hrs**

Electrically Small Antennas: Electrically small antennas and their limitations, planar inverted F antenna (PIFA), PIFA for wireless potable sets, ground-plane effects on PIFA performance, different types of PIFA, multi-frequency PIFA, Printed notch antennas, small fractal antennas, dielectric resonator antennas, small TeraHertz antennas. **4 Hrs**

Planar Antennas for Special Applications: Planar mobile handset antennas, planar laptop computer antennas, planar antennas for USB modem, planar antennas for WLAN and UWB communication. **4 Hrs**

Text Books:

1. *R. Garg, P. Bhartia, I. Bahl and A. Ittipiboon, Microstrip Antenna Design Handbook, 1st Ed., Artech House, 2001.*
2. *Broadband Planar Antennas-Design & Applications- Z. N. Chen & M. Y. W. Chia, 1st Ed., John Wiley & Sons, 2006.*

Reference Book:

1. *Compact and Broadband Microstrip Antennas-K-L. Wong, 1st Ed., John Wiley & Sons, 2002.*

EC6324 ADAPTIVE ANTENNAS AND SMART ANTENNAS Cr – 3

Introduction: Basics of linear antenna arrays, circular antenna arrays and phased antenna arrays. Concept of adaptive antennas and smart antennas, adaptive processing using minimum variance distortionless technique, application of smart antennas. **5 Hrs**

Direct Data Domain Least Square Approaches to Adaptive Processing: Direct data domain least square procedures, eigenvalue method, forward method, backward method, forward-backward method, main beam construction for prevention of signal cancellation. **5 Hrs**

Mutual Coupling in Adaptive Antennas: Mutual coupling among an array of dipoles, compensation using open-circuit voltages and minimum norm formulation, effect of mutual coupling for constant jammers and constant signals, compensation for mutual coupling for constant jammers and constant signals, effect of thermal noise on the adaptive algorithm. **10 Hrs**

Direction of Arrival (DOA) Estimation and Adaptive Signal Processing for Smart Antennas: Problem formulation, transformation matrix to compensate undesired electromagnetic effects, DOA estimation for a semicircular array, adaptive processing using a single snapshot from a non-uniformly spaced array in presence of mutual coupling and near-field scatterers, DOA estimation using a phased array on a conformal hemispherical surface, DOA estimation using cyclostationarity, DOA estimation in a multipath environment. **12 Hrs**

Direct Data Domain Least Squares Space-Time Adaptive Processing (STAP): Signals and information, signal processing method, direct data domain space-time approach, least squares forward processor, least squares backward processor, direct data domain least squares STAP for circular arrays, knowledge-based STAP processing. **4 Hrs**

Text Books:

1. *Smart Antennas – T. K. Sarkar, M. C. Wicks, M. Salazar-Palma and R. J. Bonneau, 1st Ed., Wiley-Interscience, 2003.*
2. *Smart Antennas for Wireless Communication: With MATLAB- F. Gross, 1st Ed., McGraw Hill, 2005.*

Reference Books:

1. *Smart Antennas for Wireless Communications: IS-95 and Third-Generation CDMA - J. C. Liberti and T. S. Rappaport, 1st Ed., Prentice Hall, 1999.*
2. *Smart Antenna Engineering - Ahmed El-Zooghby, 1st Ed., Artech House, 2005.*

EC-6326 MILLIMETER WAVE COMMUNICATION SYSTEMS Cr – 3

Millimeter Wave Characteristics: History of millimeter wave development, propagation characteristics of millimeter wave, attenuation of millimeter wave by atmosphere, rain and foliage loss, channel performance at 60 GHz, Gigabit wireless communications, short range communication and enhanced security, development of millimeter wave standards, coexistence with wireless backhaul. **8 Hrs**

Modulation Techniques for Millimeter Wave Communications: On/Off Keying (OOK), Phase Shift Keying (PSK), Frequency Shift Keying (FSK), Quadrature Amplitude Modulation (QAM), Orthogonal Frequency Division Multiplexing (OFDM). **6 Hrs**

Millimeter Wave Transceivers: Millimeter wave link budget, transceiver architecture, transceiver without mixer, receiver without local oscillator, millimeter wave calibration. **4 Hrs**

Millimeter Wave Antennas: Path loss and antenna directivity, antenna beamwidth, maximum possible Gain-to-Q, polarization, beam steering antenna, millimeter wave design consideration, antennas for millimeter wave communication. **6 Hrs**

Millimeter Wave MIMO Systems: Spatial diversity of antenna arrays, multiple antennas, multiple transceivers, noise coupling in a MIMO system, potential benefits for millimeter wave systems, spatial diversity, frequency diversity and temporal diversity, advantages of single carrier frequency domain equalization (SC-FDE) over OFDM for millimeter wave systems. **6 Hrs**

Millimeter Wave Application Systems: Radio stations at 50 GHz, wireless LAN systems, WPAN and broadband wireless access systems at millimeter wave band, wireless train communication systems, intelligent transport systems (ITS) using millimeter wave technology, satellite broadcasting systems in millimeter wave band, millimeter wave technology for broadband wireless communication using high altitude platform (HAP). **6 Hrs**

Text Books:

1. *Millimeter Wave Communication Systems-K-C. Huang, Z. Wang, Wiley-IEEE Press, 2011.*
2. *Modern Millimeter Wave Technologies-T. Teshirogi & T. Yoneyama (Ed), IOS Press, 2000.*

Reference Books:

1. *E. Carey and S. Lidholm, Millimeter-wave Integrated Circuits, Springer, 2005.*
2. *Millimeter Wave Technology in Wireless PAN, LAN, and MAN - S-Q. Xiao, M-T. Zhou (Ed), CRC Press, 2008.*

SCHOOL OF MECHANICAL ENGINEERING

SPECIALIZATION: MANUFACTURING PROCESSES AND SYSTEMS

ME6101 PROJECT PLANNING AND CONTROL Cr-4

Project Management Concepts and Needs Identification

Attributes of a Project, Project Life Cycle, The Project management Process, Global Project Management, Benefits of Project Management, Needs Identification, Project Selection, Preparing a Request for Proposal, Soliciting Proposals, Project organization, the project as part of the functional organization, pure project organization, the matrix organization, mixed organizational systems. **13 Hrs**

Project Planning and Scheduling

Design of project management system; project work system; work breakdown structure, project execution plan, work packaging plan, project procedure manual; project scheduling; bar charts, line of balance (LOB) and Network Techniques (PERT / CPM), Crashing. **13 Hrs**

Project Monitoring and Control and Project Performance

Planning, Monitoring and Control; Role of Production, Planning & Control (PPC), New Product Development & Process Design, Aggregate Planning: Relevant cost; Evaluation of strategic alternatives (Level, Chase and mixed, types of capacity, Economics and Diseconomies of scale, Developing capacity alternatives Project Audit; Project Audit Life Cycle. **12 Hrs**

The Project Manager

Responsibilities of the Project Manager, Skills of the Project Manager, Developing the Skills needed to be a Project Manager, Delegation Managing Change, Developing a Winning Proposal, Proposal Preparation, Proposal Contents, Pricing Considerations, Proposal Submissions and Follow-Up, Customer Evaluation of Proposals. **10 Hrs**

Text Books:

1. *Project Management,* James P. Clements & Jack Gido, Cengage Learning, 5th edition, 2012

Reference Books:

1. *Project Management: A Managerial Approach*, Jack R. *Meredith*, Samuel J. *Mantel*, Jr., 8th Edition, *Wiley Publications,* August 2011

ME 6102 CNC AND ADAPTIVE CONTROL Cr-4

Introduction to Numerical Control in Computer Aided Manufacturing – Components of CNC system – Types of CNC systems – Open loop and Closed loop control systems

Drives and Controls – Interpolators for CNC machine tools – Principal types of CNC machine tools and their constructional features. **10 Hrs**

Design consideration – Tooling for CNC – Sensors for Adaptive Control of CNC machine tools. **10 Hrs**

SMART manufacturing

CNC part programming – Manual and computer assisted part programming – Post processors – CNC part programming with CAD/CAM systems. **10 Hrs**

Programmable Logic Controllers (PLC) - Hardware, Ladder logic programming of PLCs using basic functions-Timers and counters-Advanced programming with control and arithmetic instructions. **18 Hrs**

Text Books:

1. *Mastering CAD/CAM*, Ibrahim Zeid, Academic Publishers, 3rd edition, 1999

Reference Books:

1. *CAD/CAM/CIM,* P.Radhakrishna, S.Subramanuam, V.Raju, Edition, 3. Publisher, New Age International (P) Limited, 2008
2. *Advances in adaptive control,* K.S. Narendra, PERGAMON PRESS,1994
3. *PLC & Industrial automation,* Madhuchhanda Mitra & Samarjit Sengupta, Penram International Publishing (India) Pvt. Ltd. , 2009, ISBN-978-81-87972-17-4

ME6103 METAL FORMING AND METAL CASTING Cr-4

Forming: Classification of metal forming processes; basic metal working concepts and plasticity. Elements of theory of plasticity: Stress-Strain / strain rate, strain rate, analysis of strain, Yield stress, yield conditions (Mises/Tresca), anisotropy in yielding, flow behavior of the material and determination of flow stress, instability, workability, residual stresses. **12 Hrs**

Analysis of metal flow in metal forming processes: slip line field theory, Upper bound solution, application to extrusion and indentation problems, Slab methods; Mechanics of rolling, forging, drawing, extrusion. Friction and surface integrity: formability, friction and lubrication in metal working; theories of friction and lubrication, measurement of friction in metal forming, powder forming. **12 Hrs**

Formability of sheet metals: Principle, process parameters, deep drawing, forces in circular cup drawing forming limit criteria, drawability of sheet metal, anisotropy in sheet metal, forming limit diagram (FLD), stretch forming, plate bending, press brake forming, spinning. **10 Hrs**

Casting: Survey and scope, Solidification and pure metals and alloys, Solidification of actual casting, Risering, Riser design, Risering curves, NRL methods, Feeding distance, Risering of complex casting, Gating, System and their characteristics. **8 Hrs**

Gating design: Types of gates and design considerations, pattern design considerations and testing, various moulding processes, gases in metals, fluidity of metals, casting defects and casting quality measurement and improvement techniques. **6 Hrs**

Text Books:

1. *Technology of Metal Forming Processes,* S. Kumar, PHI Ltd, 2008
2. *Principle of Metal Working,* G.W. Rowe, ISBN: 8123904282
3. *Casting Technology and Cast Alloys,* A.K. Chakrabarti, PHI Ltd., 2005

Reference Books:

1. *Metal forming and the Finite-Element Method,* S. Kobayashi, S. Oh, T. Altan, Oxford University Press, USA, 09-Mar-1989
2. *Manufacturing Technology,* Vol. – I, P.N. Rao, Tata McGraw Hill, 2007 reprint
3. *Plasticity for Mechanical Engineers,* W. Johnson & P.B. Mellor, London, Princeton, N.J., Van Nostrand [1962]
4. *Metal Forming: Fundamentals and Applications,* T. Altan, S.Oh & H.L. Gegel, American Society for Metals, 1983

ME6104 METROLOGY AND QUALITY CONTROL Cr-04

Metrological concepts: Needs of high precision inspection, Precision & Accuracy, Errors-Abbe's alignment principle & Airy's support effect, problems associated with high precision measurements. **5 Hrs**

Standards for measurement – Material standards, Wavelength standards, standards traceability and their calibration. **5 Hrs**

Limit, Fit & Gauges- Limits, Various tolerances and their specifications, Principle of gauge design**,** Limit gauges for tapers. Selective assembly & interchangeability. **5 Hrs**

Gear and Thread Measurements: Screw Thread terminology, Errors in Threads, Pitch errors, Measurement in various elements of a thread. Gear terminology, Spur gear measurements- run out, pitch, concentritivity, profile, lead, alignment, backlash, chordal thickness method, Parkinson's gear tester. **5 Hrs**

Surface & Form Metrology: Measurement of straightness, flatness, waviness, roughness, roundness (Talyround instrument), & The Taylor –Hobson Talysurf.

Laser Metrology: Application of Laser in precision measurements, Laser interferometer, specle measurements, Laser scanners. **4 Hrs**

Machine Tool Metrology: Alignment tests on Lathe, Milling Machines, Drilling Machines, Acceptance tests for Shapers & Planers. **6 Hrs**

Co-ordinate measuring machines: Types of CMM, Computer controlled co-ordinate measuring machines. Electronic inspection & measuring machines, Multidimensional Auto-gauging & Sorting machines. **8 Hrs**

Quality Assurance: Statistical Quality Control, Control Charts, Sampling distributions, Process Control Charts for Attributes & Variables. Acceptance Sampling, OC Curve, Sampling plans, AOQL, AQL, and Selection of Sampling Plans. **6 Hrs**

Total Quality Management: T.Q.M. Philosophy, Deming's approach to TQM, Quality Circle, Total Quality Control, Juran's ten steps to Quality Improvement, Kaizen System, ISO-9000& TQM, Taguchi methods, orthogonal arrays & Quality Audit. **4 Hrs**

Text Books:

1. *Engineering Metrology,* R.K. Jain, Khanna publishers, 1997

Reference Books:

1. *Statistical Quality Control,* E.C. Gantt, McGraw Hill , 2001
2. *Statistical Quality Control,* M.S. Mahajan, Dhanpat Rai & Sons., 2012

ME6105 METAL CUTTING TECHNOLOGY Cr-4

Steriometry of cutting tools: Basic shape of cutting tools: The wedge, concept of rake & clearance angle & its advantages & disadvantages, systems of description of tool geometry & nomenclature, Tool-in-hand system. Machine Reference system (ASA) & its planes & axes. Tool Reference system (ORS & NRS) & its planes & axes. Interrelation between different systems of rake angle, Conversion of tool angles from one system to another-Master line method. **8 Hrs**

Tool Materials: Requirements of cutting tool materials, Tool material properties, Major classes of tool materials, carbon tool steels, medium alloy steels, high speed steels, cast alloy steels, cemented carbide tools, cermet tools, ceramic tools, CBN tool, and polycrystalline diamond tools. Development of tool materials: coated carbides. CVD & PVD, Indexable inserts, groove geometry, edge preparations, wiper geometry, insert clamping methods, High speed machining, hard machining and comparison with grinding operations, technological processes including hard machining, equipment & tooling for hard machining, characterization of hard machining processes. **8 Hrs**

Mechanism of chip formation: Mechanism of chip formation in machining. Levy lodes theorem, Classification of chips & factors involved in chip formation. Brief description on orthogonal & oblique cutting. Causes & amount of chip flow deviation. Free & Restricted cutting. Geometry & characteristics of chip forms (chip reduction coefficient or cutting ratio, shear angle), Dynamic shear strain in chip formation. Velocity relationship, kronenberg relationship, BUE formation. Effect of cutting variables on chip reduction coefficient. Criticism of single shear plane theory. Chip formation in drilling & milling. **8 Hrs**

Mechanics of Metal cutting: Benefit of knowing & purpose of determining cutting forces. Cutting force components & their significances. Stablers rule, Merchant's circle diagram (MCD): Assumptions & its use. Frictional & shear plane force systems. Advantageous use of MCD & some limitations of use of MCD. Development of cutting forces under orthogonal & oblique cutting, Stress in conventional shear plane & Energy of cutting process. Ernst-Merchant angle relationship & Lee-shaffers relationship. Obliquity effects in restricted cutting, Effect of wear land on force system, computation of cutting forces & empirical relations, Merchants second solution & machining constant, Bridgeman effect, Design requirements of dynamometer, Dynamometer for turning process, drilling. Design of single point & high production cutting tools, Tool tips, optimization of tool shape & chip breakers. **8 Hrs**

Contact phenomena: Nature of contact between chip & tool, Determination of natural contact length, Hahns & Zorev analysis, stagnant phenomena at contact surfaces, Formation of BUE & contact phenomena, Kinetic coefficient of friction & stresses at chip tool interface. **5 Hrs**

Thermal aspects & cutting fluids: Heat generation in metal cutting, shear plane temperature, average chip tool interface temperature, theory of cutting fluid action at the chip tool interface & techniques of application, hot machining, Dry machining & minimum quantity lubrication (MQL). **5 Hrs**

Tool wear, tool life & machinability: Mechanism of plastic failure, form stability, progressive tool wear & causes, flank & crater wear, Taylors tool life equation, Tool life (Definition in R&D, industries or shop floor), factors affecting tool life, derivation of Taylors tool life equation, woxens tool life equation, experimental techniques for evaluating Taylor exponent, wear measurement methods. Machinability criteria, tests & indices, factors affecting machinability. Role of variation of machining parameters or factors on machinability of work materials. Possible ways of improving machinability of work materials, Dynamic characterstics of the cutting processes & machine tool, stability analysis, chatter & vibration in machine tools. **4 Hrs**

Surface finish & surface integrity: Numerical assessment of the surface, Effects of parameters on surface finish, measures of surface roughness, expressions for surface roughness in machining with single point tool, surface integrity**,** methods of improvement. **2 Hrs**

Economics of metal cutting: Different costs involved in machining, Economic tool life: Gilberts model, Optimum cutting speed & tool life for minimum cost & maximum production. **2 Hrs**

Text Books:

1. *Metal cutting (Theory & practice),* A. Bhattacharya, Central Pub.,1984
2. *Fundamental of machining & machine tools*, Boothroyd & Knight, Taylor & Francis Pub., 2006

Reference Books:

1. *Metal cutting (Theory & practice),* David A.Stephenson & J.S.Agapiou, Taylor & Francis Pub.2006
2. *Metal cutting principles*, M.C. Shaw, Oxford Pub., 2005
3. *Metal cutting,* Trent & Wright, Elsevier Pub.,4th edition, 2000
4. *Metal cutting & tool design,* V. Arsinov, MIR Pub., 3rd edition, 1996.

ME6106 OPTIMIZATION TECHNIQUES Cr-4

Introduction to optimization: Design vector, design constraints, constraint surface, objective function, classification of optimization problems **3 Hrs**

Classical optimization techniques: Single variable optimization, multi-variable optimization, multi-variable optimization with equality constraints, lagrange multipliers. **4 Hrs**

LPP: Mathematical Formulations of the problem, general linear programming problem, canonical and standard forms Fundamental properties of solution to L.P.P. Computational procedure. Simplex method, Artificial variable techniques, Big-M & Two phase method, Problem of Degeneracy. **7 Hrs**

Concept of Dualities: Fundamental properties of duality, Fundamental theorem of Duality and simplex Method, Dual Simplex algorithm. **3 Hrs**

Sensitivities Analysis: Discrete changes in cost vector and requirement vector.

IPP: Importance, Gomory's cutting plane method, Branch and Bound Technique.

NLPP: Problem of constrained maximum and minimum Kuhn Tucker conditions, quadratic programming, Wolfe's & Beale's Method. Goal programming. **3 Hrs**

Game Theory: Two person zero sum games. The Maximin and Minimax principle, Mixed strategies, Graphical solutions of 2 x n and n x 2 games. Dominance property, Reduction of game problem as an L.P.P. **4 Hrs**

Job sequencing: Principal assumptions, Processing 'n' jobs through 2 machines, 'n' jobs through 3 machines, 2 jobs through 'm' machines and 'n' jobs through 'm' machines. **4 Hrs**

Decision Theory: Introduction, payoff table, opportunity loss or regret table, decisions under uncertainty, laplace criterion, maximin or minimax principle, maximax or minimax principle, hurcuilicz principle, decisions under risk-maximum likelihood criteria, expectation principle, expected opportunity loss or expected regret decision trees. **4 Hrs**

Replacement models: Replacement problems, replacement model for items whose maintance cost increases with time (money value constant), and with change in money value, selection of best machine, replacement of items that fail suddenly, individuals & replacement policies. **6 Hrs**

Statistics & design of experiments: Frequency Distribution & Histograms, Probability & its Distribution, Measures of Central Tendency & Distribution, Presentation of Statistical Data. Confidence intervals, Hypothesis Testing, Correlation, Liner & Multiple Repression Analysis, Signification Testing. Full & fractional factorial experiments, analysis of variance, Latin squares, response surface methodology, Taguchi techniques. **6 Hrs**

Simulation: Basic concepts, discrete events, generation of random numbers & events using Monte carlo method, simulation of queuing systems, variance reduction techniques, applications. **4 Hrs**

Text Books:

1. *Engineering Optimization: Theory and Practice,* S. S. Rao, New Age International (P) Ltd, 3rd Edition
2. *Design & Analysis of Experiments,* M.C. Montgomery, John Wiley & Sons, 2006

Reference Books:

1. *Quality & Robust Engineering,* M.S. Phadke, Prentice Hall; 1 edition (May 22, 1989)
2. *Taguchi Techniques in Quality Engineering,* Phillip J. Ross, McGraw-Hill Professional; 2 edition (August 1, 1995)
3. *Engineering Optimization,* Ravindran and Phillips, McGraw Hill, 2006.

ME6107 ADVANCED MANUFACTURING AND FABRICATION PROCESSES Cr-4

Considerations in process selection. Overview of non-traditional machining.

Mechanics of material removal, tool material selection & design, effect of process parameters on MRR, accuracy and Surface integrity, advantages and limitations; applications of various advanced machining processes like Ultrasonic Machining, Abrasive jet machining, abrasive-water jet machining, ECM, ECH, EDM, Wire-EDM, EBM, PM, LBM and Ion-beam machining processes. Hybrid machining like ECG, ECDM. **20 Hrs**

Advanced forming & welding: Process principle and applications of explosive forming techniques, electro-hydraulic and electro-magnetic forming, fundamentals of contour roll forming and stress forming techniques. **6 Hrs**

Fundamentals of electron beam welding, Laser Beam welding and Ultrasonic welding processes. **6 Hrs**

Classification of welding process, physics of welding arc, Arc characteristics, Effects of shielding gas on arc, arc blow. Mechanism and types of metal transfer, welding power sources. Characteristics, Duty cycle and power factor static and dynamic characteristics.

Welding process: TIG, MIG, MMAW, CO_2 welding, SAW, Resistance, friction, diffusion, Ultrasonic, electron beam and laser welding process. **8 Hrs**

Heat flow in welding, residual stress measurement, distortion prevention, Weldability of plane carbon, Stainless steel and Aluminium, Cast iron. **8 Hrs**

Text Books:

1. *Modern machining process,* P.C. Pandey, H.S. Shan, TMH, 33rd reprint, 2008
2. *Non conventional machining,* P.C. Mishra, Narosa publishing house, 3rd reprint, 2005

Reference Books:

1. *Manufacturing science,* A. Ghose & A.K. Mallik, East-west press, 2001
2. *Welding & Welding technology,* R. Little, TMH, 2004
3. *Welding Engineering & Welding Technology,* R. S. Parmar, Khanna Publisher, 1997

ME6109 ROBOTICS AND ROBOT APPLICATIONS Cr -4

Robot Introduction – Definition – Classification and Specification. Work envelops and other basic parameters of Robots. **8 Hrs**

Mechanics: Kinematic Parameters and Modeling- Direct and Inverse Kinematics - Differential motion and jacobians – Introduction to Dynamics Path planning – Trajectory Planning and Control – Slew, Joint interpolated and straight line motion.

Hardware: Drives: Electric, Hydraulic, Pneumatic and their relative merits. **10 Hrs**

Sensors, And-effectors: Tool handling and work handling and special devices like harmonic drives, servo valves etc. **10Hrs**

Vision: Low level and higher level vision – fundamentals, image acquisition, recognition, interpretation – a few basic examples in Robotics. **10 Hrs**

Robot Applications

Robot Programming concepts – Off-line programming and simulation – work cell application development: requirements; modeling, work cell calibration; layout planning, Case studies in assembly, machine loading / unloading, palletizing, deburring etc. **10 Hrs**

Text Books:

1. *Robotics Technology & Flexible Automation,* S.R. Deb & S. Deb, Tata McGraw Hill, 2010

Reference Books:

1. *Robot Dynamics & Control,* M.W. Spong & M.Vidyasagar, Wiley, 1989
2. *Robotic Systems: Advanced Techniques & Applications,* S.G. Tzafestas, Kluwer, Academic publisher, 1992

ME6122 FINITE ELEMENT ANALYSIS Cr -3

Introduction: Overview of FEM, General description of FEM, Engineering Application of FEM. **6 Hrs**

Basic Procedure: Discritization of domain, interpolation models, simplex, complex and multiplex elements, selection of the order of the interpolation, convergence requirements, linear interpolation polynomialsin Global and local co-ordinate system. **7 Hrs**

Higher Order and Isoparametric Elements: Higher order elements in terms of Natural co-ordinate system, one dimensional elements using classical interpolation polynomials, two dimensional elements using classical interpolation polynomials, Isoparametric elements, numerical integration. **7 Hrs**

Derivation of Element Matrices and Vectors: Direct Approach, Variatonal approach, derivation of Finite Element equations using Rayleigh-Ritz and Galerkin Method, Solution of eigenvalue problems using weighted Residual approach. **6 Hrs**

Assembly of Element Matrices and Derivation of System Equations: Co-ordinate transformations, Assemblage of Element equations, Incorporation of boundary conditions. **4 Hrs**

Application to Solid Mechanics and Heat Transfer Problems: Formulation of solid and structural mechanics, formulation of FE equations(Static Analysis), application to (Truss Elements, Beam Elements, Triangular Elements, Tetrahedral Elements) **6 Hrs**

Text Books:

1. *The Finite Element Method in Engineering,* S.S. Rao, Elsevier Publications, 2011

Reference Books:

1. *Concept and Application of FEM,* R.D. Cook & D.S. Malkus, Wiley, 3rd edition, 1989

ME6124 RAPID RESPONSE MANUFACTURING Cr- 3

Definition & concept of Rapid Prototyping processes, Need of RP in context of batch production, Lead time reduction in design; Concurrent engineering: concepts, tools and techniques; Basic principles of RP, Steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP. **8 Hrs**

Classifications of different RP techniques based on raw material, layering technique (2D or 3D) and energy sources; **4 Hrs**

Process Technology, Basic concept & process detail of RP process like Stereo-lithography (SL), Solid foil polymerization, Selective laser sintering, Selective powder binding, Ballistic particle manufacturing both 2D and 3D, Fused Deposition Modeling, Shape Melting, Laminated Object Manufacturing, Solid Ground Curing, Repetitive Masking and deposition, Beam Inference Solidification, Holographic Interference Solidification. **10 Hrs**

Special Topic on RP using metallic alloys Solid ground curing laminated object manufacturing, fused deposition modeling, three dimensional printing, ballistic particle manufacturing & vacuum casting, their advantages applications & limitation. **6 Hrs**

Programming in RP, Modeling, Slicing, Internal Hatching, Surface Skin Fills, Support Structure **2 Hrs**

Technology for Rapid Prototyping: Selection of materials, Development of 3D model & transforming it to the RP machine, Supporting techniques & development of the workpiece, Post processing part removal, part cleaning, post curing, part finishing, machine accuracy & part accuracy. **4 Hrs**

Some case studies & application of Auto industry, die-making industry, medical appliances, etc. **2 Hrs**

Text Books:

1. *Rapid prototyping & Manufacturing Fundamental of Stereo-lithography,* Paul F. Jacobs, SME Publications,1992

Reference Books:

1. *Rapid Prototyping,* Amitabha Ghosh, East West Press Pvt. Ltd, 1997
2. *Rapid Prototyping, Principles and Application,* C.K. Chua, K.F. Leong and C.S. Lim, World scientific publishing Co. Pvt. Ltd., Singapore, 2005

ME6126 FLEXIBLE MANUFACTURING SYSTEMS Cr-3

Definition and broad characteristics of flexible Manufacturing Cells, Systems, Islands and Flexible transfer lines. **6 Hrs**

Place of flexible manufacturing systems in CIM – The FMS relational: Economics and technological justification for FMS **6 Hrs**

Design and Planning: the role of associated technologies such as GT, JIT and simulation Installation, Operation and evaluation – Scheduling problems **8Hrs**

FMS hardware CNC machines tools, robots, AGVs, ASRs, Inspection and Cleaning stations – Control aspects of FMS-DNC of machine tools, cutting tools, robots, quality control and inventories. **8Hrs**

Personnel and infrastructural aspects – Flexible machining cells and islands – Flexible assembly Systems, structure, control and applications – FMS in action: Typical case studies. Future prospects. **8 Hrs**

Text Books:

1. *Flexible manufacturing systems: current issues and models,* F.Choobineh, R. Suri, Industrial Engineering and Management Press, Institute of Industrial Engineers, 1986

Reference Books:

1. *Modeling, simulation, and control of flexible manufacturing systems: a Petri net approach,* Vol 6 of Series in Intelligent Control and Intelligent Automation, M.C.Zhou, K.Venkatesh, World Scientific, 1999
2. *Automation, production systems, and computer-integrated manufacturing*, M.P.Groover, Prentice Hall, 2007
3. *Flexible manufacturing systems: the technology and management*, R.A.Maleki, Prentice Hall, 1991

ME6128 ARTIFICIAL INTELLIGENCE IN MANUFACTURING Cr-3

Artificial Intelligence – Definition - Components – Scope – Application Areas;

Knowledge–Based Systems (Expert Systems) – Definition – Justification – Structure – Characterization; **6 Hrs**

Knowledge Sources – Expert – Knowledge Acquisition – Knowledge Representation – Knowledge Base – Interference Strategies – Forward and Backward Chaining; Expert System Languages – ES Building Tools or Shells; typical examples of Shells – IITM Rule. **10 Hrs**

Commercial software for manufacturing applications in CAD, CAPP, MRP II, Adaptive control, robotics, Process control, Fault diagnosis, Failure Analysis; Process Selections, GT etc. Linking expert systems to other software such as DBMS, MIS, MDB; Process control and Office automation. **10 Hrs**

Case studies of typical applications in tool selection, Process selection, Part Classification, inventory control, Process Planning etc. **10 Hrs**

Text Books:

1. *Artificial intelligence in manufacturing,* P. Mowforth, IFS Publication, 1987

Reference Books:

1. *Artificial Intelligence in Manufacturing,* C. Emerson, CSA Journal Division, 2009
2. *Artificial intelligence and automation,* Vol 3 of Advanced series on artificial intelligence, N.G. Bourbakis, World Scientific, 1998
3. *Artificial intelligence applications in manufacturing,* A.F. Famili, D.S. Nau & S.H. Kim, AAAI Press, 1992

ME6132 INTELLIGENT MANUFACTURING AND CONDITION MONITORING Cr-3

Introduction – Role of sensors in manufacturing automation – operation principles of different sensors – electrical, optical, acoustic, pneumatic, magnetic, electro-optical and vision sensors. **6 Hrs**

Condition monitoring of manufacturing systems – principles – sensors for monitoring force, vibration and noise, selection of sensors and monitoring techniques. **6 Hrs**

Acoustic emission – principles and applications –

Concepts of pattern recognition. **8 Hrs**

Sensors for CNC machine tools – linear and angular position and velocity sensors. **6 Hrs**

Automatic identification techniques for shop floor control – bar code scanners, radio frequency, systems – optical character and machine vision sensors – smart/ intelligent sensors – integrated sensors, Robot sensors, Micro sensors. Manufacturing of semi conductor sensors and fibre optic sensors – principles, applications **10 Hrs**

Text Books:

1. *Intelligent Manufacturing,* L.Underwood, Universities Press,2009
2. *Condition monitoring: engineering the practice,* E.D. Yardley, Professional Engineering, 2002

Reference Books:

1. *Intelligent condition monitoring and diagnosis systems: a computational intelligence approach,* Vol 93 of Frontiers in artificial intelligence and applications, K. Wang, IOS Press, 2003.
2. *Condition monitoring and control for intelligent manufacturing,* Springer series in advanced manufacturing, L. Wang & R.X. Gao, Springer, 2006

ME6134 PRODUCTION SYSTEM DESIGN AND CONTROL Cr-3

Basic concepts of systems and concerning chaos / problems; System design and decision support / making system for management; System design approach; Evolution of production systems; Elements of production systems and their interaction; Types and classifications of production systems; Recent manufacturing strategies; Dynamics and performance evaluation of production systems; Basic concept of production system modeling, evaluation, optimization and simulation; Introduction to concurrent engineering and its applicability to production system design. **9 Hrs**

Production levels and modes; Design requirements of production system; Architecture and methodologies of production system; Group technology: process and machine characteristics; JIT and Kankan; Automation systems for production; Layout designs: flexible, computer aided and computer integrated layouts; Concept of computer-aided design (CAD) and computer aided process planning (CAPP), Computerized layout planning. **9 Hrs**

Production control strategies; Demand forecasting; Capacity and aggregate production planning; Inventory Management; Logistic planning; Production scheduling; Shop floor control; Process planning: alternative solutions and computer aided techniques; Assessing cost effectiveness; Importance of optimization in production; Global optimization methods; **6 Hrs**

Concept of artificial intelligence and its application for optimization. Framework of production systems and supply management; Performance measurement and tools of production systems; Simulation and modeling of production systems

Design of information system for manufacturing, machining, etc; Parts oriented production information system; Information networking for strategic information system for production; Development of knowledge based production system, Concept of on-line and off-line production control systems, Role of computer in production management systems. **6 Hrs**

Social production modes; Human centered production system; Basic concept of KANSI and its role in production system; Social system for production system, Concepts and approaches to manufacturing excellence

Case studies of production support system, machinery manufacturer and replacement of production machine. **6 Hrs**

Text Books:

1. Manufacturing Systems Engineering, K. Hitomi, Viva Books, New Delhi, 2008

Reference Books:

1. Re-Engineering the Manufacturing System: Theory and Applications, Robert E. Stein, Marcel Dekker, New York, 2005
2. Computer Integrated Manufacturing Technology and Systems, U. Rembold, C. Blume & R. Dillmann, Marcel Dekker, New York, 2004
3. Manufacturing System Redesign-Creating the Integrated Manufacturing Environment, David O'Sullivan, Prentice Hall, New Jersey, 2002

ME6136 COMPETITIVE MANUFACTURING STRATEGIES Cr-3

Introduction to the Competitive Environment in Market, WTO Agreement and its Effect on Indian Industries, Manufacturing as a Competitive Strategy, Competitive Advantages and Disadvantages. **4 Hrs**

Manufacturing Challenges, Manufacturing Audit, Product Variety, Modular Design, Introduction to DFX Methodologies, Design For Manufacturing, Simulation as Tools for Competitive Manufacturing. **4 Hrs**

Selection of Manufacturing Strategies / Systems for Different Manufacturing Scenarios, Dedicated Manufacturing Systems, Flexible Manufacturing Systems (FMS), Cellular Manufacturing Systems (CMS), Re-Configurable Manufacturing System (RMS), Computer Integrated Manufacturing (CIM). **4 Hrs**

MRP-I, MRP-II, TQM, TPM, Six Sigma, Agile Manufacturing, JIT Manufacturing, Kanban System, Rapid Response Manufacturing, World-Class Manufacturing, Molecular Manufacturing, Value Analysis / Engineering and Cost Reduction, Product Life Cycle Management (PLM), Lean Principles and their impact on Manufacturing Cycle Time, Lean Manufacturing, Lean Six Sigma, Core Process Reengineering, Kaizen. **6 Hrs**

Effect of Industrial Activity on Environment, Basic Concepts of Clean Technologies and Eco Friendly Manufacturing; Design, Planning and Implementation of Clean Production, Type of Wastes in Manufacturing Industries, Causes of Waste Generation and its Elimination Strategies, Resource Recovery and Recycling, Product Reengineering / Remanufacturing and Demanufacturing. **10 Hrs**

Dynamic Customer, Supply Chain Management, Vendor Development and Rating, Evolution, Characteristics and Features of ERP, Network Based Manufacturing, Intelligent and Innovative Manufacturing, E-Manufacturing, Factories of Future (FOF). **8 Hrs**

Text Books:

1. Manufacturing Excellence in Global Markets, W. Euershelm, Chapman & Hall, 1996

Reference Books:

1. Manufacturing Systems Design and Analysis: Context and Techniques, B. Wu, Springer, 1994
2. Intelligent Manufacturing Planning, P. Gu, Chapman & Hall, 1995
3. Fast Track to Waste Free Manufacturing, J.W. Davis, Productivity Press, USA, 1999
4. Clean Production: Environment & Economic Perspective, K.B. Misra, Springer - Verlog, 1996
5. Techniques of Value Analysis & Engineering, L.D. Miles, McGraw-Hill, 1972

ME6138 TOTAL PREDICTIVE MAINTENANCE Cr-3

Overview of Maintenance Engineering, Modern Trends in Maintenance Technology, Maintenance Paperwork, Maintenance Work Measurement & Standards, Maintenance MIS, Preventative Maintenance & its Key Elements, Predictive Maintenance, Reliability Centered Maintenance. **6 Hrs**

Introduction, History, Definition, Need, Objectives, Benefits, Philosophy, Implementation Stages & Strategies of TPM, Small Group Working, QX & QM Matrix, One-Point Lesson. **6 Hrs**

Understand Equipment Failures (Hows & Whys), Identify Causes and Types of Equipment Failures, MTBF and MTTR, When & How to Report Problems, Root Cause Identification Tools (Five Why Tools), Methods for Defect Reduction, Over usage Reduction, Quality Tools such as Cause & Effect Diagram, Capability Analysis, TPM Mater Plan. **8 Hrs**

Continuous Improvement of Equipments, Measuring Overall Equipment Effectiveness (OEE), Calculating & Maximizing OEE, Measurement & Maintenance, Six Big Losses, Implementing 5S, i.e. Sort, Set-in-Order, Shine, Standardize & Sustain, Visual Control, Twelve steps of TPM Development. **8 Hrs**

Building an Effective Maintenance Team, Operator, Maintenance Personnel & Management involvement, Creating Tracking and Checklist Programs, Utilizing Visual Guides, Communicating TPM through the whole Facility, TPM Training & Education, Safety-Health-Environment (SHE), Role of Computers in TPM, Application of TPM in Process Industries, Administrative & Support Departments. **8 Hrs**

Text Books:

1. Introduction to TPM: Total Productive Maintenance, (English Translation, 1988), S. Nakajima, Cambridge, MA: Productivity Press, 1988

Reference Books:

1. Maintenance Engineering & Management, R.C. Mishra & K. Pathak, Prentice Hall of India Publication, 2002

2. Handbook of Maintenance Management, 2nd Edition, F. Herbaty, New Jersey, Noyes Publications, 1990

ME6142 QUALITY ENGINEERING AND MANAGEMENT Cr-3

Attributes of quality, Evolution of philosophy of Quality Management, Economics of quality and measurement of cost of quality, Data presentation techniques for quality analysis, Statistical process control, Use of control charts and process engineering techniques for implementing quality plan, Machine and process capability analysis, statistical tolerance analysis. **10 Hrs**

Acceptance sampling: Single, double and multiple sampling plans, Acceptance sampling for variables Reliability analysis and predictions, Bath-Tub Curve, Exponential and Weibull distribution in modelling reliability, System reliability **10 Hrs**

Experimental designs and factorial experiments: Concepts of randomization, Blocking and Confounding Single factor randomized design, ANOVA, 2 k factorial experiments Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design. **10 Hrs**

Fundamentals of TQM: Customer orientation, Continuous improvement, Total participation; Some important philosophies and their impact on quality (Deming, Juran, Crossby), QC Tools, Components of Total Quality System (TQS), Quality audit, Introduction to ISO 9000 and 14000 standards. **6 Hrs**

Text Books:

1 Quality and Process Improvement, Mark A. Fryman, Delmar Thomson Learning, 2002

2. Quality Planning and Analysis, Juran J M and Gryna F M, Tata McGraw Hill, 2001

ME6144 ADVANCED MATERIALS AND PROCESSING Cr-3

Polymers and polymerization: structure and properties of thermoplastics and thermosets, engineering applications, property modifications -mechanical, thermal behaviour, Processing of polymers . **6 Hrs**

Advanced Composite Materials and their Applications: Introduction, Fibers, Matrix materials, Material forms and fabrication methods, Current applications, fabrication of composites. **6 Hrs**

Concepts of composite mechanics: Macro-mechanics Material symmetry, Engineering constants, Coordinate transformations, Thermal effects, Moisture effects

Concepts of Micromechanics: Effective properties, Survey and model comparison from strength of materials approximations, continuum mechanics approaches. **6 Hrs**

Laminate analysis: Stress-strain relationship for an orthotropic lamina, Orthotropic properties in plane stress, Deformation due to extension and bending, A, B, D matrices, Hygro-thermal behavior, Average stress-strain properties **6 Hrs**

Concepts of failure of laminates: Tensile failure of fiber composites, Compressive failure of fiber composites, Effect of multi-axial stresses (failure criteria by Tsai-Wu, Hashin, etc.). **6 Hrs**

Glasses, glass ceramics, fabrication methods, metal matrix and ceramic matrix composites, Processing of ceramics: thermal spraying, ion beam machining, laser and electron beam processing, super-plastic forming, Thin films and their deposition, diamond coating techniques, Tribological applications. **6 Hrs**

Text Books:

1. Elements of Material Science & Engineering, V. Vlack, Pearson Education, 2008

Reference Books:

1. Materials science and engineering: An introduction, W.D. Callister, John Wiley & Sons, 2007
2. Materials Science and Engineering: A First Course, V. Raghavan, PHI Learning Pvt. Ltd., 2004
3. Fundamentals of composites manufacturing: materials, methods and applications, A.B. Strong, Society of Manufacturing Engineers, 2008
4. Carbon fiber composites, Deborah D.L. Chung, Butterworth-Heinemann, 1994

ME6146 DESIGN FOR MANUFACTURABILITY AND DFX Cr-3

Introduction & background for design & manufacturing; Product development process Tools, Concepts of design for manufacturing (DFM); Role of DFM in product specification, standardization, design, development, functional requirements, material and process selection; Modern approaches to product design, i.e. concurrent engineering, reengineering, benchmarking, quality function deployment, etc. **10 Hr**

Introduction to product life cycle analysis; New product development and management; Components of DF'X'; Design for 'X' approaches, i.e. design for assembly, disassembly, quality, six sigma, performance, safety, durability, maintainability, eco-friendliness, aesthetics, reuse, recycling, remanufacturing, packaging, shipment, etc. **6 Hr**

Human engineering considerations in product design; Value engineering and product design. **4 Hr**

Design rules for selection of materials and processes; Material performance indices, comparative property charts, costs, etc.; Evaluation of single and multi-attribute utilities; Part geometry and tolerances; Shape factor; Prototyping; Mathematical Optimization; Formation of objective and constraint functions; Factorial analysis. **10 Hr**

Design knowledge presentation; DFX manuals; compiling, verification and standard tools; Implementing DFX tools; Case studies on product design for 'X' **4 Hr**

Legal issues in product design and intellectual property rights; Role of computers in product design. **2 Hr**

Text Books:

1. Product Design & Manufacturing, A.K. Chitale & R.C. Gupta, Prentice Hall of India, New Delhi, 2002

Reference Books:

1. Design for 'X': Concurrent Engineering Imperatives, G.Q. Huang, Chapman & Hall, 2001
2. Product Design & Manufacturing, John R. Lindbook, Prentice Hall, New Jersey, USA, 2005
3. Product Design: Techniques in Reverse Engineering & New Product Development, K. Otto & K. Wood, Person Education, Singapore,1998

ME6148 WORK SCIENCE Cr-3

Appraisal of method study and work measurement techniques. Mechanization and training in these techniques. Standard data derivation and applications; PMT systems-MTM, WF systems. Major variables, Motion time tables and installation of PMT system in industries. **18 Hr**

Man-machine system analysis, system components and system reliability. Physical and mental load measurement. Effects of environment factors on worker performance. Design and arrangement of various control and display devices.

18Hr

Text Books:

1. Introduction to work study, G.Kanawaty, International Labour Organization, 1992

Reference Books:

1. Ergonomics: human factors in work, machine control and equipment design, Vol 12, Ergonomics Research Society, Taylor & Francis Ltd, 1969
2. Text book of work study and ergonomics, S. Dalela, Standard Publishers, 1971
3. Time and motion study, Vol 11, Canadian Time Study Association, Sawell Publications, 1962
4. Advances in occupational ergonomics and safety, Vol 2, S. Kumar, IOC Press, 1998

ME6152 MATERIALS MANAGEMENT Cr-3

Introduction to materials, productivity and role of materials management, techniques of improved material productivity, cost reduction and value improvement. Role of purchasing in cost reduction. **8 Hrs**

Value analysis for right choice and rationalization of materials. Purchasing research identification of right sources of right suppliers. Vendor rating. **8 Hrs**

Standardization and variety reduction, negotiation and purchase. Price analysis. Organization of purchasing functions. Product explosion. Materials requirement planning, make or Buy decisions. Incoming materials control, acceptance sampling, inspection. Vendor satisfaction plans. Vendor and supplier reliability. **8 Hrs**

Inventory management. ABC-VED analysis. Various inventory models. Inventory models with quantity discounts. Exchange curve concept and coverage analysis. JIT. Information systems for inventory management. Stores management and ware housing. Optimal stocking, issuing policies. Inventory management of perishable commodities. Surplus management. Design of inventory distribution systems. Monitoring MM effectiveness, Case studies. **12 Hrs**

Text Books:

1. Materials management: procedures, text and cases, A.K. Datta, PHI, 2004

Reference Books:

1. Materials management: an integrated approach, P. Gopalakrishnan, M. Sundaresan, PHI, 2004
2. Materials management: a systems approach, G.K. Beekman-Love, L. Nieger, Martinus Nijhoff Social Sciences Division, 1978
3. Materials Management: Text and Cases, A.K. Chitale, R.C. Gupta, PHI, 2007

ME6154 MECHATRONICS Cr-3

Introduction – Definition of Mechanical Systems, Philosophy and Approach. Embedded Microprocessor Systems-Hardware Structure, Software Design and Communication. Programmable Logic Devices, Application Specific ICs, Automatic Control and Real time Control Systems, Fuzzy Logic Control. Systems and Design, Modeling, Analysis and Simulation, Man-Machine Interface. **6 Hrs**

Sensors and Transducers – Classification, Development in Transducer Technology-Semiconductors, Thick film and Thin film Elements, Signal Processing, Opt-electronics – Shaft Encoders, CD Sensors, Optical probe for Metrology, Vision System, etc. **8 Hrs**

Drives and Actuators – Hydraulic and Pneumatic Drives, Electrical Actuators such as Servo Motor and Stepper Motor – Drive circuits, Open and Closed loop control, Piezoelectric and Magnetostrictive Actuators. **8 Hrs**

Materials, Static and Dynamic characteristics, Illustrative examples for Positioning, Vibration Isolation etc. Micromechatronic Systems – Microsensors, Microactuators, Smart Instrumentation, Micro-fabrication techniques **8 Hrs**

Lithography, etching, Microjoining etc; Application Examples. Case studies – Examples of Mechatronic Systems from Robotics, Manufacturing, machine Diagnosis, Road Vehicles and Medical Technology. **6 Hrs**

Text Books:

1. *Mechatronics*, N.P. Mahalik, Tata McGraw-Hill, 2003

Reference Books:

1. *Mechatronics, Infinity Science Series, Engineering Series*, G. Hegde & G.S. Hegde, Jones & Bartlett Learning, 2010
2. *Mechatronics: an introduction*, R.H. Bishop, Taylor & Francis, 2006
3. Mechatronics, M.D. Singh & J.G. Joshi, PHI Learning Pvt. Ltd., 2006
4. Mechatronics: principles and applications, G.C. Onwubolu, Butterworth-Heinemann, 2005
5. Mechatronic systems: Fundamentals, R. Isermann, Birkhäuser, 2005
6. System Dynamics: Modeling and Simulation of Mechatronic Systems, Karnopp, Wiley-Interscience, 2000

ME6156 AUTOMATIC CONTROL SYSTEMS Cr-3

Introduction; Mathematical models of physical system; Feedback characteristics of control systems; **8 Hrs**
Control systems and components; **8 Hrs**
Time response analysis, design specifications and performance indices; **8 Hrs**
Concepts of stability and algebraic criteria; Root locus technique; Frequency response analysis; **6 Hrs**
Stability in frequency domain; Introduction to design;
State variable analysis and design. **6 Hrs**

Text Books:

1. Automatic control: An introduction, C.R. Webb, McGraw-Hill, 1964

Reference Books:

1. Automatic control systems, R.M. Phelan, Cornell University Press, 1977
2. Automatic control engineering, McGraw-Hill series in mechanical engineering, Francis Harvey Raven, McGraw-Hill, 1995
3. Control Systems Engineering, I.J. Nagrath, New Age International, 2006
4. Advances in automatic control, Vol 754 of The Kluwer international series in engineering and computer science, M.Voicu, Springer, 2004
5. Problem solver in automatic control systems/robotics, REA's problem solvers, M. Fogiel, Research and Education Association, Research & Education Assoc., 1982

ME6158 ENVIRONMENT-BENIGN MANUFACTURING Cr-3

Manufacturing challenges, Effect of industrial activity on environment, Definition and concept of environment-benign manufacturing, World-class manufacturing, Manufacturing audit, Dynamic customer, Basic concept of reclamation, recovery, recycling, reuse and re-manufacturing, **6 Hrs**

Concept of lean manufacturing, Lean vision and principles, Value added and non-value added activities, JIT and waste, Core process reengineering, Concept of product take-back strategy, Innovation-driven cleaner technologies, Resource scarcity as a stimulus for manufacturing innovations, **6 Hrs**

Cleaner manufacturing technologies: concepts, development, limitation, design and planning, Basic concepts of cleaner manufacturing implementation tools: Environmental Impact Assessment (EIA), Life Cycle Assessment (LCA), Environmental Technology Assessment, Chemical Assessment, Environmental Audit, Energy Audit, Risk Audit and Waste audit. **6 Hrs**

Concept of End-of-Pipe technology and waste reduction at source, Type of wastes, causes of waste generation and its minimization / elimination in manufacturing industries, Benefits and impact of waste minimization (WM) on manufacturing cycle time, Waste free manufacturing drivers, **6 Hrs**

Waste minimization programs, Waste minimization circles, Concept of Kaizen & its impact on waste minimization, Hidden waste in industries **6 Hrs**

Basic concept of molecular manufacturing, eco-efficiency, eco-labels, Case studies of cleaner manufacturing: LCA of machining, sand casting and other manufacturing processes . **6 Hrs**

Text Books:

1. Fast Track to Waste Free Manufacturing, J.W. Davis, Productivity Press, US, 1999
2. Clean Production, K.B. Misra, Springer – Verlog, 1996
3. Environment conscious manufacturing, S.M. Gupta & A.J.D. Lambert, CRC Press, 2008

ME6162 DESIGNS OF EXPERIMENT Cr-3

Introduction to Factorial design: Basic Definitions and principles, Experimental designs and factorial experiments: Concepts of randomization, Blocking and Confounding, Single factor randomized design, ANOVA, 2^k factorial experiments, General full factorial design

Fitting Regression models: Linear regression models, Estimations of parameters in regression model. ` **6 Hrs**

Response Surface Method: Method of steepest ascent, Analysis of Second order response surface, Multiple response optimization **6 Hrs**

Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design. **6 Hrs**

Optimization problem formulation - Design variables, constraints, objective function and variable bounds. **8 Hrs**

Single- variable; Single Variable Optimization Algorithm: Bracketing Melliotls Exhaustive Search Method and bounding phase Method. ; Region Elimination Methods: Fibonacci Search method and Golden section search method. Gradient based methods, Newton-Raphson method, Bisection Method, Secant Method, and Cubic Search Method.

Multivariable Optimization Algorithms: Direct search methods. Simplex search method and Hooke-Jeeves pattern search method. Gradient based methods- Cauchy's (steepest descent) method and Newton's method. **10 Hrs**

Text Books:

1. Design and Analysis of Experiments, D.C. Montgomery, John Willey & Sons, 2009
2. Engineering Optimization: Theory and Practice, S.S. Rao, John Wiley & Sons,2009

Reference Books:

1. Quality Engineering using robust design, M.S. Phadke, Pearson Education, 2008.
2. Optimization in Engineering Design, Kalyanmoy. Deb, PHI, 2005

ME6164 MANUFACTURING SYSTEMS ENGINEERING Cr-3

Types of manufacturing – product variety vs production volume; Manufacturing decisions, strategies & priorities; Manufacturing system paradigm; Characteristics and types of manufacturing systems; Factors and tools for system development; Advent of advanced manufacturing technologies & systems; Product manufacturing cycle; Stages & phases of system development life cycle (SDLC); Problem definition & system modeling; System reliability & its assessment; Considerations of reliability & maintainability in product design; FMECA & criticality analysis; Fault tree analysis; Design for reliability (DFR). **8 Hrs**

Components of manufacturing system; Manufacturing system classification; Facility layout; Modified manufacturing cells; Single system manufacturing cells; Group technology (GT) & creation of part families; GT machine cell design; Basic concept of flexibility; Types of manufacturing flexibility; Flexible manufacturing systems (FMS); Computer integrated manufacturing systems (CIMS). **8 Hrs**

Product components & new product; Importance & stages of new product development (NPD); Designing a product for customer; Basic concept of design for manufacturing (DFM) & design for assembly (DFA); Sequential engineering vs concurrent engineering (CE); Fundamentals, essence & techniques of CE; Major elements & building blocks of CE; Designing a CE environment. **8 Hrs**

Parametric design & quality control during manufacturing; Introduction to design of experiment (DOE) & Taguchi technique for manufacturing system design; Introduction to material requirement planning (MPR) and manufacturing resource planning (MPR-II), Just-in-time (JIT) production system; Theory of constraints (TOC); Synchronous manufacturing; Basics of demand forecasting techniques & inventory management system; Lot sizing & operation scheduling . **4 Hrs**

Introduction to world class manufacturing system (WCMS); Waste reduction; Toyota production system & the Toyota way; Basic concept of integrated logistics & supply chain management (SCM); Tapping human resources & building a learning environment; Introduction to knowledge management system (KMS) . **4 Hrs**

Case study of automation in manufacturing unit, productivity in Japan & India, failure of refrigerators in GE Company and implementation of simultaneous engineering at Cadillac Automobile Company (division of General Motors) **4 Hrs**

Text Books:

1. Manufacturing systems engineering, B. Bhadury, Macmillan India, 2009

Reference Books:

2. Mechanical system design, R.C. Mishra & Simant, PHI, 2009
3. Mechanical system design, W.E.Eder & W.Gosling, Pergamon Press, 1965
4. Mechanical system design, S.Patil, Jaico Publishing House, 2008
5. Mechanical system design, K.U.Siddiqui, M.K.Singh & M.A.Faruqi, New Age International (P) Ltd., Publishers, 2007

ME 6201 ADVANCED FLUID MECHANICS Cr-4

Fluid Forces: body forces, surface forces- stress tensor and concept of pressure. **4 Hrs**

Description of Fluid motion: Eulerian and Lagrangian description; substantial derivative, Reynolds' transport theorem; Rates of linear and angular strain; Rotation, Decomposition of Velocity gradient matrix into symmetric and anti-symmetric part; normal and shear stresses; Navier–Stokes' equation. Transport theorems, constitutive equations, derivation of Navier Stokes equations for compressible flow. **12 Hrs**

Applications of Navier Stokes equations: plane Poiseuille flow and Couette flow, Hagen-Poiseuille flow, flow between two concentric rotating cylinders, Stoke's first and second problem, and Hiemenz flow. **8 Hrs**

Slow Viscous flow: Stokes and Oseen's approximation, Boundary layer: derivation, exact solutions, Blasius, Falkner Skan, series solution and numerical solutions, Approximate methods, Momentum integral method. **8 Hrs**

Two–dimensional potential flow: Conformal transformation technique; Flow round a sharp edge; Joukowski transformation; Flow around an ellipse; Kutta condition and flow over thin air foil; Schwarz–Christoffel transformation. **6 Hrs**

Singular Perturbation Technique in fluid mechanics: Flow past a sphere; Linear stability theory; physical description of fluid instabilities; Klein–Helmholtz and Rayleigh–Taylor instabilities; Orr–Sommerfeld equation; Rayleigh's equation; stability; Stability curves; Squire's theorem for an inviscid flow. **10 Hrs**

Text Books:

1. *Fluid Mechanics*, R.N. Fox and A.T McDonald, John Wiley & Sons, 4th Ed., 1994.
2. *Introduction to Fluid Mechanics*, Shaughnessy, Oxford University Press, 4th Ed. 2004.

Reference Books:

1. *Fundamentals of Fluid Mechanics*, Schlitching, Springer Links, 2000
2. *Fluid Dynamics*, V.L. Streeter, Mc Graw-Hill, 1971
3. *The dynamics and thermodynamics of compressible fluid flow*, Vol. I & II, A.H. Shapin, The Ronald Press Co., 1955.
4. *Foundations of Fluid Mechanics*, S.W. Yuan, Prentice Hall of India, 1976.
5. *Advanced Engineering Fluid Mechanics*, Muralidhar & Biswas, Alpha Science International Ltd, 2005.
6. *Principles of Fluid Mechanics and Fluid Machines*, N.Pillai and C.R.Ramakrishnan, University Press, Hyderabad, 2006.
7. *Fluid Dynamics*, 3rd revised Ed., Dr. J.K Goyal & K.P. Gupta., Pragathi Prakasan, Meerut, 1989.
8. *Hydrodynamics Theory & Application*, Robertson, Prentice Hall of India, 1965.
9. *Fluid Mechanics*, P.K. Kundu, I.M. Kohen& D.R. Dowling, Academic Press, 2011

ME 6202 ADVANCED REFRIGERATION & AIR-CONDITIONING Cr-4

Vapour Compression Refrigeration: Analysis of vapour compression refrigeration system (theoretical and actual); Effect of various factors on the performance of vapour compression refrigeration system; Multiple evaporator systems; Compound vapour compression systems; Low temperature and multi-temperature systems, Cascade System. **8 Hrs**

Vapour Absorption Refrigeration: Analysis of vapour absorption refrigeration system (theoretical and actual); LiBr-H2O system; Electrolux systems; Binary mixtures; Analysis of absorption systems using analysis and rectification columns. **8 Hrs**

Refrigeration Equipments: Compressors (reciprocating and centrifugal); Expansion devices; Condensers; Evaporators; Controls used in refrigeration systems. Properties of refrigerants; Their development and applications; Principles of various other refrigeration systems. **8 Hrs**

Psychrometry: Definitions and processes, Advanced psychrometric calculations, Cooling load calculations – Determination of U factor –short method calculation; Human comfort; Comfort chart; Sol-Air temperature air-conditioning system. **8 Hrs**

Low Temperature Refrigeration: Joule Thompson coefficient – liquefaction of air – hydrogen –helium - Applications of cryogenics. **6 Hrs**

Room Air Distribution: Friction losses in ducts - Duct design, Air filters clean rooms – Air curtain. **6 Hrs**

Air-Conditioning: Different types of air conditioning plants and air conditioning equipments. **4 Hrs**

Text Books:

1. *Refrigeration and Air Conditioning,* Stoeker, W.P. and Jones, J.W., 2nd Ed., Tata McGraw-Hill, 1982.
2. Refrigeration and Air Conditioning, Manohar Prasad, New Age International, 1996.

Reference Books:

1. *Refrigeration and Air Conditioning*, C.P.Arora, Tata McGraw Hill, 1988
2. *Refrigeration and Air Conditioning*, Domkundwar and Arora, Dhanpat Rai and Sons, 1974
3. *Refrigeration and Air Conditioning*, P.L.Balaney, Khanna Publication, 2003
4. *Refrigeration and Air conditioning*, Jordan and Priester, Prentice Hall of India, 1974.
5. Ashrae Hand Book', 4 Vol., Current Ed., 2007.

ME 6203 ADVANCED THERMODYNAMICS Cr-4

Review of Fundamentals: Zeroth, first and second laws of thermodynamics; Concept of entropy generation. **6 Hrs**

Thermodynamic Relations: Exergy concept; Physical and Chemical Exergy; Helm Holtz function, Gibb's function, Reciprocity relation, Availability analysis for processes and cycles, Thermodynamic relations, Maxwell's relations, T-ds equations, specific heat relations, energy equation, Joule Thomson effect, Clausius-Claperyon Equation, Criteria for Equilibrium, Gibb's phase rule, The third law of thermodynamics. **12 Hrs**

Thermodynamics of Mixtures: Thermodynamic properties of homogeneous mixture and multiphase, multi-component systems; Chemical availability. **10 Hrs**

Irreversible Thermodynamics: Stability; Phase transition; Critical phenomena; Nernst postulate; General systems; Classical irreversible thermodynamics. **10 Hrs**

Statistical Thermodynamics: Thermodynamics probability, Maxwell statistics, Fermi Dirac and Bose – Einstein statistics, Entropy and probability, Degeneracy of energy levels, Partition functions. **10 Hrs**

Text Books:

1. *Fundamentals of Classical Thermodynamics*, G.J. Van Wylen & R.E. Sonntag, Willy Eastern Ltd. 1989 (Chapters: I, II & III)
2. *Principles of Thermodynamics*, J. Hsieg, McGraw Hill, 1978.

Reference Books:

1. *Thermodynamic for Engineers*, A.S. Michael, Prentice Hall, 1972.
2. *Engineering Thermodynamics*, 2nd Ed., P.K. Nag, McGraw Hill, 1995.
3. *Thermodynamics*, 4th Ed., J.P. Holman., McGraw Hill, 1988.
4. *Statistical Thermodynamics*, Lee and Sears, Addition Wesley, 1976.
5. *Thermodynamics for Chemists*, V. Nastrand & S. Glasstne, 1974.
6. *Engg Thermodynamics for Engineers*, M.D. Burghardt, Harper & Row, NY, 1987.
7. *Advanced Thermodynamics for Engineers*, K. Wark, McGraw Hill, NY, 1987.
8. *Introduction to Chemical Engineering Thermodynamics*, K. Smith & H.C. Van Ness, McGraw Hill, 1987.

ME6204 THERMAL SYSTEMS DESIGN AND OPTIMIZATION Cr-4

Formulation of the Design Problem: Design variables, constraints and limitations, requirements and specifications; Conceptual design, Steps in the design process (examples from thermal systems), Material selection. **8 Hrs**

Modeling of Thermal Systems: Types of models, mathematical modeling, physical modeling and dimensional analysis, curve fitting. **6 Hrs**

Acceptable Design of a Thermal System: Initial design, design strategies, some application illustrations (cooling of electronic equipment, heat transfer equipment, fluid flow systems etc.). **8 Hrs**

Problem Formulation for Optimization: Optimization in design, final optimized design, objective function, constraints, operating conditions, types of thermal systems, practical aspects in optimal design (choice of variables for optimization, sensitivity analysis, dependence on objective function and change of concept or model), Knowledge-based design and additional considerations, professional ethics. **8 Hrs**

Constrained and Unconstrained Optimization: Optimization of unconstrained problems, optimization of constrained problems, applicability to thermal systems, search methods (single variable problem, unconstrained search with multiple variables and multivariable constrained optimization). **8 Hrs**

Integer Programming: Penalty function method. **4 Hrs**

Use of Artificial Intelligence Techniques: Neural network, fuzzy logic and genetic algorithm in thermal systems design and optimization (simple examples). **6 Hrs**

Text Books:

1. Design and Optimization of Thermal Systems, Y. Jaluria, CRC Press, 2007.
2. Optimization methods, S. S. Rao, PHI, 1998

Reference Books:

1. *Optimization in Engineering Design*, K. Deb, Prentice Hall, 2002.
2. *Design of Thermal Systems*, W.F. Stoecker, McGraw-Hill, 1971.
3. *Thermal Design and Optimization*, Bejan, G. Tsatsaronis, M.J. Moran, Wiley, 1996.
4. *Developments in the Design of Thermal Systems*, R. F. Boehm, Cambridge University Press, 1997.
5. *Design & Simulation of Thermal Systems*, N.V. Suryanarayana, McGraw Hill, 2002.

Cr-4

ME 6205 ADVANCED HEAT & MASS TRANSFER

Conduction: Review of heat transfer modes; Heat conduction in anisotropic media, Inverse heat conduction problems, Probability methods in heat conduction, Heat conduction in porous media, Phase change problems, Ablation, Moving heat source problems, Non-Fourier conduction problems. **12 hrs**

Convection: Derivation of boundary layer equations by order of magnitude analysis; Solution of boundary layer equations by similarity variable and integral methods; Natural convection in boundary layers; Integral method, Boussinesq approximation and scaling analysis, Transport equations with discontinuous property variation. Conservation laws for interface phenomena, Concept of hydrodynamic and thermal stability, Rayleigh-Benard convection, Turbulent heat transfer, and Turbulent Prandtl number. **12 hrs**

Radiation: Basic definitions, surface properties, view factors; Radiation exchange in black and grey enclosure; Radiosity matrix; Interaction of surface radiation with other mode of heat transfer. Radiative properties of real surface; Equation of radiative transfer in participating media; Radiative properties of molecular gases; Exact solution for one dimensional grey media; Approximate solution methods; Pn and Sn approximate methods; Zonal method; Monte Carlo method for thermal radiation; Experimental techniques on radiation heat transfer. **12 hrs**

Mass Transfer: Basic definitions; Fick's law of diffusion; Species conservation equation; Solution of one dimensional mass transfer problem, Associated illustrations. **12 hrs**

Text Books:

1. *Fundamentals of Heat and Mass Transfer*, F.P. Incropera and D. P. Dewit, John Wiley & Sons, 1998.
2. *Heat and Mass Transfer*, J.P. Holman, Tata McGraw Hill, 1989.

Reference Books:

1. *Heat and Mass Transfer*, Y.A.Cengel, Tata McGraw Hill, 2003
2. *Convective Heat Transfer*, L.C. Burmister, John Willey and Sons, 1983.
3. *Fundamentals of Heat and Mass Transfer*, C. P. Kothandaraman, New Age International, 1997.
4. *Extended Surface Heat Transfer*, D. D. Kern, New Age International Ltd., 1985.
5. *Analysis of Heat and Mass Transfer*, E. R. D. Eckert and R.M. Drake, McGraw Hill, 1980.
6. *Convective Heat and Mass Transfer*, W.M. Kays and W. Crawford, McGraw Hill Inc., 1993.
7. *Fundamentals of Heat Transfer*, Krith, Taylor & Francis, 2007.
8. *Radiation Heat Transfer*, E.M Sparrow, R.D Cess, 2009
9. *Conduction Heat Transfer*, V.S Arpaci, Ginn Press, 1991.

ME6206 COMPUTATIONAL HEAT AND FLUID FLOW Cr-4

Brief Overview of the Transport Equations: Solution of linear and non-linear Ordinary Differential Equations (ODE) applicable in Thermal and Fluids Engineering. **4 Hrs**

Partial Differential Equations: Classification, Introduction to Finite Difference, Finite Volume and Integral Methods. Solution of Steady and Transient Heat Conduction Problems, Solution of Laplace and Poisson type PDEs. **8 Hrs**

Error Analysis: Introduction of Explicit and Implicit Schemes. Stability and Consistency of Numerical Methods. Numerical Errors, Fourier Stability Analysis of typical Solution Algorithms. Alternate Direction Implicit (ADI) method. **8 Hrs**

Solution of Simultaneous Algebraic Equations: Tri-Diagonal-Matrix Algorithm (Thomas Algorithm), Gauss-Siedel and Gauss-Jordon Methods. Strongly Implicit Procedures (SIP Solvers – Stone's Algorithm) for two and three dimensional problems. **8 Hrs**

Vorticity Problems: Vorticity Transport Equation in Two Dimensions, Solution of Fluid Flow Problems by Stream-function Vorticity Method. Examples of Derived Boundary Conditions for Stream Function and Vorticity. Derivation of Pressure Poisson Equation and Their Solution. **8 Hrs**

Navier Stokes Equation: Integration of Navier Stokes equation in primitive variables and Scalar Transport Equation. Various Schemes of Discretisation – First and Second Order Upwind Schemes, QUICK, Hybrid, Exact and Exponential Differencing Schemes. **6 Hrs**

Solution of Navier Stokes and Scalar Transport Equations: Introduction to Staggered Grid Layout. Solution by SIMPLE, SIMPLER and SIMPLEC Algorithms. **6 Hrs**

Text Books:

1. *Numerical heat transfer fluid flow*, S.V. Patankar, Hemisphere Publishing Corporation, 1980.
2. *Computational Fluid Flow and Heat Transfer*, K. Muralidhar and T. Sundararajan, Narosa Publishing House, New Delhi, 1995.

Reference Books:

1. *Computer Simulation of flow and heat transfer*, P.S., Ghoshdasdidar, Tata McGraw-Hill Publishing Company Ltd., 1998.
2. *Computational Fluid Mechanics and Heat Transfer*, D.A. Anderson, I.I. Tannehill, and R.H. Pletcher, Hemishphere Publishing Corporation, New York, USA, 1984.
3. *Computational Techniques for Fluid Dynamics Fundamental and General Techniques*, C.A.J. Fletcher, Springer-Verlag, 1987.
4. *Numerical Fluid Dynamics*, T.K. Bose, Narosa Publishing House, 1997.
5. *Introduction to Computational Fluid Dynamics*, P. Niyogi, S.K. Chakrabartty and M.K. Laha, Pearson Edu., 2005
6. *Fundamentals of Fluid Dynamics*, T.K. Sengupta, University Press, Hyderabad, 2004.
7. *Computational Fluid Dynamics*, Versteeg and Malasekharan, Prentice Hall, 2007.

ME 6207 FINITE ELEMENT ANALYSIS OF HEAT AND FLUID FLOW Cr-4

Introduction: Numerical techniques to solve boundary value problems, General procedure for FEA, Elements and shape functions, Interpolation functions for C^0-continuity and C^1-continuity. Finite Element Formulation, Method of weighted residuals, Galerkin method, Laws of Heat Transfer, Boundary and initial conditions. **8 Hrs**

Steady State Heat Conduction in One Dimension: Plane walls, radial heat flow in a cylinder, conduction-convection systems. A one dimensional Problem solved using a single element – Linear element, Quadratic element, the use of numerical integration. A one dimensional problem solved using an assembly of elements. **10 Hrs**

Steady State Heat Conduction in Multi Dimensions: Two dimensional plane problems, linear and quadratic triangular and rectangular elements, Three dimensional problems, Axisymmetric problems, Finite Element formulation for axisymmetric problems. **10 Hrs**

Transient Heat Conduction Analysis: Lumped heat capacity system, Galerkin method for transient problems, One dimensional transient heat conduction problems, Time discretization using FDM, Time discretization using FEM, stability criteria, multi dimension transient heat conduction. **10 Hrs**

Convection Heat Transfer: Navier-Stokes equations, Non-dimensional form the governing equations for forced, free and mixed convection, Formulation for ideal flow (Stream function and velocity potential function in 2-D flow, Formulation for incompressible viscous flow (Stokes flow and viscous flow with inertia). **10 Hrs**

Text Books:

1. *Fundamentals of the Finite Element Method for Heat and Fluid Flow*, Roland W. Lewis, P. Nithiarasu and K.N. Seetharamu, Wiley; 1st edition, 2004.
2. *Fundamentals of the Finite Element Analysis,* David V. Hutton, Mc Graw Hill, 1st edition.

Reference Books:

1. *The Finite Element Method in Heat Transfer Analysis,* H. R. Thomas, K. N. Seetharamu, Ken Morgan, R. W. Lewis, John Wiley & Sons Inc, 1996.
2. *The Finite Element Method in Heat Transfer and Fluid Dynamics,* J.N. Reddy and D.K. Gartling, CRC; 2nd edition, 2000.

ME6208 THEORY OF COMBUSTION AND EMISSION Cr-4

Introduction: Definition, need, application, classification etc. of combustion systems, Energy sources. **2 Hrs**

Combustion and Thermochemistry: Review of property relations, Equation of state, calorific equations of state, ideal gas mixtures, Thermodynamics (1st & 2nd law for pure, non-reacting (mixture) and reacting systems); stoichiometry, absolute enthalpy and enthalpy of formation, enthalpy of combustion and heating values, adiabatic flame temperatures. **8 Hrs**

Conservation Equations: (Continuity, momentum, total & thermal energy and species); Fluid Mechanics; Heat Transfer & Mass Transfer, mass transfer rate laws, species conservation, applications of mass transfer: Stefan problem and droplet evaporation. **6 Hrs**

Chemical Kinetics: Global versus elementary reactions, elementary reaction rates, unimolecular, bimolecular and termolecular reactions, Collision theory; reaction rate and its functional dependence; Arrhenius equation; order of reaction, steric factor, collision frequency, activation energy etc. **6 Hrs**

Rates of reaction for multistep mechanisms: relation between rate coefficients and equilibrium constants, chain and chain branching reactions, chemical time scales. **2 Hrs**

Laminar premixed flame: Definition, principal characteristics; Simplified Analysis: assumptions, conservation (mass, species & energy) equations with boundary conditions and their solutions to find out temperature & mass-fraction distribution; Factors affecting flame velocity and thickness, Correlations of flame velocity & thickness; quenching; flammability & ignition, flame stabilization. **8 Hrs**

Laminar diffusion flame: Laminar Jet, Jet flame physical description, simplified theoretical descriptions, Burke-Schumann solution: assumptions, simplification and solution of mass, species, momentum & energy equation with the boundary conditions; determination of temperature & mass-fraction distribution as well as flame height, soot formation and destruction. **8 Hrs**

Droplet evaporation & combustion: Applications, Simple model of droplet evaporation, assumptions, solution of mass, species & energy equation with the boundary conditions; determination of temperature & mass-fraction distribution, mass evaporation rate, flame stand-off ratio, flame temperature, expression for transfer numbers, evaporation/burning rate constant, droplet life-time etc. **6 Hrs**

Pollutant emissions: Effects of pollutants, quantification of emissions, emission indices, various specific emission measures, emissions from premixed combustion, emissions from non-premixed combustion. **2 Hrs**

Text Books:

1. *Introduction to Combustion: Concepts and Applications*, Stephen R Turns, McGraw Hill, 2000

Reference Books:

1. *Internal Combustion Engines*, C.R. Ferguson and A.T. Kirk Patrick, John Wiley & Sons. Inc. 2001.
2. *Combustion Engineering*, G.L. Borman and K.N. Ragland, McGraw Hill, 1998.
3. *Thermodynamics for Engineers*, D.Winterbone, Advanced Elsevier, 1996
4. *Combustion Engineering*, K. Kuo, New Age Pvt. Ltd, 2005.

ME6221 GAS TURBINES AND JET PROPULSION Cr-3

Introduction: application, shaft power gas dynamics – Compressibility effect, steady one dimensional compressible flow of a perfect gas in a duct, isentropic flow in a constant area duct with friction, normal shock waves, oblique shock wave, isentropic two dimensional, supersonic expansion and compression. **8 Hrs**

Centrifugal fans Blowers and Compressors: Principle of operations, work done and pressure rise, slip factor, diffusers, compressibility effects, non-dimensional qualities for plotting compressor characteristics. Bray ton cycle, regeneration and reheating cycle analysis. **8 Hrs**

Axial Flow Fans and Compressors: Elementary theory, degree of reaction, three dimensional flow, simple design methods, blade design, calculation of stage performance, overall performance, and compressibility effects. Performance characteristics. **6 Hrs**

Combustion System: Form of combustion, important factors affecting combustion chamber design, combustion processes, combustion chamber performance, and practical problem. **3 Hrs**

Axial Flow Turbines: elementary theory, vortex theory, choice of blade profile, pitch and chord; estimation of stage performance, he cooled turbine; **3 Hrs**

Prediction of performance of simple gas turbines: component characteristic, off design shaft gas turbine, equilibrium running gas generators, off design o free turbine and jet engine, methods of displacing the equilibrium, running line, incorporation of variable pressure losses, methods of improving part load performance, matching procedure for twin spool engines, behavior of gas turbine, Gas turbine rotors and stresses. **8 Hrs**

Text Books:

1. *Theory and Design of Stream and Gas Turbine*, J.F. Lee, McGraw-Hill, 1954.

Reference Books:

1. *Gas Turbine Theory*, H. Cohen & G.F.C. Rogers, Longmans, Green, 1951.

2. *Gas and Steam Turbine Theory*, R. Yadav, Central Publishing House, 1998.

ME 6222 ADVANCED TURBO-MACHINERY Cr-3

Introduction, Classification of turbo machinery. Application of TT – theorem in turbo machinery. **4 Hrs**

Incompressible fluid in turbo machines – Effects of Reynolds Number and Mach number. Energy transfer between a fluid and a rotor - Euler turbine equation – components of energy transfer impulse and Reaction – Efficiencies. **6 Hrs**

Radial flow pumps and compressors – head capacity relationship – Axial flow pumps and compressors – Degree of reaction dimensionless parameters – Efficiency and utilization factor in Turbo Machinery. **6 Hrs**

Thermodynamics of Turbo machine processes – Compression and expansion efficiencies – Stage efficiency – Infinitesimal stage and finite stage efficiencies. **4 Hrs**

Flow of fluids in Turbo machines – flow and pressure distribution over an airfoil section – Effect of compressibility cavitations – Blade terminology- Cascades of blades – fluid deviation – Energy transfer of blades – Degree of reaction and blade spacing – Radial pressure gradient – Free vortex flow – losses in turbo machines. **8 Hrs**

Centrifugal pumps and compressors – Inlet section – Cavitation – flow in the impeller channel – flow in the discharge casing pump and compressor characteristic**.** **3 Hrs**

Radial flow turbines – inward flow turbines for compressible fluids – inward flow hydraulic – velocity and flow coefficients – gas turbine blading – Kaplan turbine – pelton wheels. **5 hrs**

***Text Books*:**

1. Lee, Theory and Design of Steam and Gas Turbine, McGraw Hill, 1954.

***Reference Books*:**

1. Yahya, Turbines, Compressions & Fans', Tata McGraw Hill, 1983.

2. D.G. Stephard, Principles of Turbo machines', Macmillan Co., 1984.
3. W.J Kerten, Steam Turbine Theory and Practice', CBS Publisher & Distributors, 1988.
4. C. Rogers, S Muttoo, Gas Turbine Theory', Long man, 1988.
5. W N.Bathe, Fundamentals of Gas Turbines', Willey & Sons, 1994.

ME6223 ALTERNATIVE FUELS FOR IC ENGINES Cr-3

Estimation of Petroleum Reserve: Need for alternate fuel - Availability and properties of alternate fuels – general use of alcohols - LPG - Hydrogen - Ammonia, CNG and LNG - Vegetable oils and Biogas – Solar - Merits and demerits of various alternate fuels. **8 Hrs**

Fuel Properties: Alcohols and gasoline blends, performance in SI engine, Methanol and gasoline blends, Combustion characteristics in engines, emission characteristics, Engine modifications. **8 Hrs**

CNG and LPG: Availability of CNG, properties, modification required to use in engines - performance and emission characteristics of CNG using LPG in SI & CI engines, Performance and emission for LPG, Hydrogen Storage and handling, performance and safety aspects. **8 Hrs**

Vegetable oils for engines: Single and dual fuel use, Engine modifications, SVO, Esterification, Performance in engines, Performance and emission characteristics. **6 Hrs**

Layout of an electric vehicle: Advantage and limitations, Specifications, System component, Electronic control system, High energy and power density batteries, Hybrid vehicle, Solar powered vehicles. **6 Hrs**

Text Book:

1. *Alternative Fuels*, Sharma, M., McGraw Hill, 1987.

Reference Books:

1. *Energy Today & Tomorrow*, M. Dayal, I & B Horishr, India, 1982.

2. *Power Plant Engineering*, Nagpal, Khanna Publishers, 1991.

3. *The properties and performance of modern alternate fuels,* SAE Paper No.841210. SAE Handbook

4. *Automotive Fuels Guide Book*, Richard L. Bechtold, SAE Publications, 1997.

ME6224 MICROSCALE HEAT TRANSFER Cr-3

Microscale heat transfer regimes, Review of thermodynamics and heat transfer **3 Hrs**

Crystal structure, Reciprocal lattice / crystal bonding, Lattice vibration **3 Hrs**

Kinetic description of dilute gases, Elementary kinetic theory, Boltzmann transport equation, Microscale heat conduction equations **6 Hrs**

Thermal lagging behavior, conservation laws, H-Theorem (2nd law), BGK models, continuum limit; the laws of Navier-Stokes and Fourier (NSF),temperature jump and velocity slip, beyond NSF; higher order methods and moment equations **10 Hrs**

Knudsen layers. Electro kinetically driven and thermomagnetic microflow and heat transfer; **6 Hrs**

Overview of different solution techniques for microscale flows and transport; Non-Fourier heat conduction . **8 Hrs**

***Text Books*:**

1. S. Kandlikar, S. Garimella, D. Li, S. Colin, M. King (2005), Heat Transfer and Fluid Flow in Minichannels and Microchannels, Elsevier Publications, ISBN: 0-08-044527-6.

***Reference Books*:**

1. C.-L. Tien, A. Majumdar and F.M. Gerner, 1998, Microscale Energy Transport, Taylor & Francis, Washington.
2. S. Kakac, L.L. Vasiliev, Y. Bayazitoglu and Y. Yener, Microscale Heat Transfer: Fundamentals and Applications, Springer, 2005, ISBN 1-4020-33591, 509 pages.

ME6225 ANALYTICAL METHODS IN HEAT TRANSFER Cr-3

Heat Conduction Equations in cartesian and polar coordinate systems. **3 Hrs**

Separation of variables method Applied to one and two dimensional heat transfer problems. **4 Hrs**

Application of Laplace transform and integral transform in heat conduction, Application of Green's function in heat conduction. **6 Hrs**

Variational methods in heat conduction. **3 Hrs**

Perturbation methods in heat conduction, Buried cable problem. **6 Hrs**

Analytical methods in non-linear heat conduction problems. Mixed and Cauchy problems of hyperbolic heat conduction equation, Dual-Phase-Lagging heat conduction equations. **4 Hrs**

Conjugate heat transfer: Review of fundamentals - energy balance approach, view factor calculations, Enclosure Analysis, Radiosity - irradiation methods, two-mode heat transfer problems - conjugate convection from different geometries without radiation, three-mode heat transfer problems - conjugate convection with radiation from various geometries, conjugate mixed convection problems. **10 Hrs**

Text Books:

1. *Analytical Heat Transfer*, Mihir Sen, University of Notre Dame, 2008.

2. *Heat Conduction*, M. N. Ozisik, McGraw Hill, 1998.

Reference Books:

1. *Inverse Problems in Heat Transfer*, M. N. Ozisik, McGraw Hill, 2000

2. *Thermal-Radiation Heat Transfer*, Siegel, R. and Howell, J. R., 4th Edition, Taylor & Francis, 2002.

3. *Heat Conduction*, S. Kakac and Y. Yener, 2nd Edition, Hemisphere, 2001.

4. *Convective Heat and Mass Transfer*, W. M. Kays and M. E. Crawford, 4th Edition, Tata McGraw Hill, 2012.

ME6226 BIO HEAT TRANSER Cr-3

Introduction: Basic parameters and heat balance equation for the human body, Human thermal physiology and thermoregulation . **4 hrs**

Psychological responses: models, thermal sensation, and thermoreception, Clothing thermal properties **4 hrs**

Bioheat Modeling: Circulation heat transfer model of the human artery and vein system, Blood perfusion heat transfer in tissues models using analytical equations, Thermoregulatory control of heat transfer of the following modes, **8 hrs**

Vaso-constriction/dilation of arteries and veins, Surface sweating rate and spatial control, Local control of shivering heat generation in tissue, Metabolic control, Respiration heat transfer model, Clothing heat transfer and water transport models by conduction through the clothing layers **10 hrs**

Thermal comfort, Heat stress, Cold stress, Human comfort and ventilation, Thermal comfort and radiation asymmetry **4 hrs**

Thermal environment interference with activities, performance, and productivity, International standards: ASHRAE, ISO and European Standards for thermal comfort. **6 hrs**

***Text Books*:**

1. Charny, C. K. 1992. Mathematical models of bio-heat transfer. Advances in Heat Transfer 22:19-153.

***Reference Books*:**

1. Fanger, P. O. 1972. Thermal Comfort: Analysis and Applications in Environmental Engineering. McGraw-Hill, New York, NY.
2. ASHRAE Handbook of Fundamentals (2005), Chapter 8.
3. Fournier, R. L. 1998. Basic Transport Phenomena in Biomedical Engineering. Taylor & Francis, Philadelphia, Pennsylvania.
4. Yang, W. 1989. Biothermal-Fluid Sciences. Hemisphere Publishing Corporation, New York.
5. Weiss, T. F. 1996. Cellular Biophysics. Volume 1: Transport. The MIT Press, Cambridge, Massachusetts.

ME6227 HEAT EXCHANGER ANALYSIS AND DESIGN Cr-3

Constructional Details: Types, fluid flow arrangements, parallel, counter and cross flow, shell and tube heat exchanger, regenerators and recuperator, condensers – Industrial applications. **6 Hrs**

Heat Transfer: Modes of heat transfer, overall heat transfer coefficient, thermal resistance, efficiency, temperature distribution and its implications, LMTD, effectiveness. **8 Hrs**

Flow Distribution: Effect of turbulence, friction factor, pressure loss, orifice, flow nozzle, diffusers, bends, baffles, effect of channel divergence, and manifolds. **8 Hrs**

Stress in Tubes, Headers Sets and Pressure Vessels: Differential Thermal Expansion, Thermal stresses, Shear stresses, Thermal sleeves, Vibration, Noise, types of failures. **6 Hrs**

Design Aspects: Heat transfer and pressure loss flow configuration effect of baffles, effect of deviations from ideality, design of typical liquid-liquid, gas-gas-liquid heat exchangers, design of cooling towers. **8 Hrs**

Text Book:

1. *Heat Exchanger Design*, A. P. Frass and M. N. Ozisik, John Wiley and Sons Inc., 1965.

Reference Books:

1. *Compact Heat Exchangers*, W. M. Kays and A. L. London, 3rd Ed., McGraw Hill, 1984.

2. *Industrial Heat Exchangers- A basic guide*, G. Walker, McGraw Hill V Book Co., 1980.

3. *Process Heat Transfer*, D. Q. Kern, McGraw Hill Book Co., 1984.

4. *Heat Exchangers*, E. A. D. Saunders, Longman Scientific and Technical, New York, 1988.

ME6228 ENERGY CONSERVATION AND MANAGEMENT Cr-3

Significance and Scope of Energy conservation and Management, Basic principles and total energy concept, First law optimization, availability. Exergy analysis, Second law optimization of thermal systems. Energy audits and conservation programme, elements of energy accounting. **6 hrs**

Plant energy studies: concepts, resources, procedures and implementation. Energy accounting indices, energy budget and variance analysis- statistical and engineering models. Economic aspects, payback. Waste Heat recovery. **6 hrs**

High, medium and low temperature applications, Methods of energy conservation in domestic and industrial sectors; case studies. **5 hrs**

Energy sources, Classification and characterization of fuels (fossil and bio-fuel), conversion and utilization, environmental and economic issues, optimum use of energy resources. **6 hrs**

Thermodynamic cycles, Principles of thermal energy conversion in boilers, internal combustion engines and gas turbines, cogeneration and combined cycle power generation, fuel cells and MHD technology, solar, wind and nuclear power, utilization of industrial heat. **6 hrs**

Energy management in industry, Environmental and economic evaluation advanced pollution control technology. **7 hrs**

***Text Books*:**

1. R. Gold Stick and A. Thumann, Principles of Waste Heat Recovery, PHI, 1986.

***Reference Books*:**

1. D. Y. Goswami, F. Kreith, Energy Conversion- CRC Press, 2007
2. V. Kadambi, and M. Prasad, Introduction to energy conversion turbo machinery: Energy conversion cycle- Wiley Eastern, New Delhi, 1974

ME6229 INTRODUCTION TO NANO-TECHNOLOGY Cr-3

Characteristic scale for quantum phenomena, nanoparticles, nano-clusters, nanotubes, nanowires and nano dots. **5 Hrs**

Transport, optical, thermal and mechanical properties of nano tubes, synthesis of nano-materials using chemical techniques, application of nano materials, micro and nano electromechanical systems. **7 Hrs**

Characterization of materials, resistivity probing, hall mobility, optical mapping, auto radiography, electron micrography, phase identification, chemical assessment, spectrophotometry, differential thermo analysis. **7 Hrs**

Determination of physical structure, optical methods of structure determination, optical microscopy, electron microscopy (SEM, TEM, AFM etc.). **5 Hrs**

Nanofluidics and surfaces: liquid structure near solid-liquid interfaces (simple liquids; layering electrolytes: Poisson-Boltzmann equation; Debye Hückel approx.) **6 Hrs**

Hydrodynamic boundary condition: slip vs. non-slip, electro kinetic effects (electrophoresis, electro osmotic effect, electro viscous effect), surface reconstruction, dangling bonds and surface states. **6 Hrs**

***Text Books*:**

1. *Introduction to Nano Technology*: Charles P. Poole Jr. & F.J. Owens, Springer, 2003

Reference Books:

1. *Experimental Techniques of Surface Science,* Woodruff and Delchar, Cambridge Univ. Press (Cambridge, 1994)

2. *Advances in Nano Science & Tech*., Sharma Ashutosh, Jayesh, CSIR (New Delhi), 2004

ME6231 EXPERIMENTAL METHODS IN THERMAL ENGINEERING Cr-3

Introduction: Theoretical, computational and experimental research methodologies, objectives of experiments, monitoring, control and research. **6 Hrs**

System and variable Identifications for mechanical systems, planning of instrumentation, Design of Experiments (DOE). **6 Hrs**

Basic Concepts in Measurements: Generalized description of measurement system, operational description of a general measurement system and elimination methods of interfering inputs to the desired inputs. **8 Hrs**

Measurement Methods: Null and deflection methods of measurements, analog and digital measurements, static and dynamic measurements, accuracy, precision, sources of errors in measurements, and uncertainty analysis. **8 Hrs**

Performance Characteristics, Order of Instruments and Calibration. **2 Hrs**

Sensors and Transducers: Data sampling, signal conditioning and acquisition, examples of transducer for mechanical measurements, working demonstration, pressure measurement, flow measurement, temperature and heat flux measurement**.**

6 Hrs

Text Book:

1. *Experimental Methods for Engineers*, Holman, J. P., Tata McGraw Hill Book Company, New Delhi, 2010.

Reference Books:

2. *Mechanical Measurements*, Thomas G. Beckwith and Lewis Buck, Narosa Publishing House, 2009.

3. *Measurement Systems - Applications and Design*, Ernest, O. D., Tata McGraw Hill Book Company, New Delhi, 2011.

ME6232 NON-CONVENTIONAL ENERGY SYSTEMS Cr-3

Solar Radiation: Solar thermal process, heat transfer devices, solar radiation measurement, estimation of average solar radiation. **6 hrs**

Solar energy storage: stratified storage, well mixed storage, comparison, Hot water system, practical consideration, solar ponds, Non-convective solar pond, extraction of thermal energy and application of solar ponds. **10 hrs**

Wind energy: The nature of wind. Wind energy resources and modeling. **3 hrs**

Geothermal energy: Origin and types of geothermal energy and utilisation. **2 hrs**

OTEC: Ocean temperature differences. OTEC systems. Recent OTEC developments. **3 hrs**

Wave energy: Fundamentals. Availability Wave-energy conversion systems. **5 hrs**

Tidal energy: Fundamentals. Availability Tidal-energy conversion systems. **3 hrs**

Energy from biomass: Photosynthesis; Biomass resource; Utilisation of biomass. **4 hrs**

***Text Books*:**
1. S.P.Sukhatme, Solar Energy Principle of Thermal Collection and Storage', Tata McGraw Hill, 1990.

***Reference Books*:**
1. G.L. Johnson, Wind energy systems, Prentice Hall Inc., New Jersey, 2002.
2. J.M.Kriender, Principles of Solar Engineering', McGraw Hill, 1987.
3. V.S. Mangal, Solar Engineering', Tata McGraw Hill, 1992.
4. N.K.Bansal, Renewable Energy Source and Conversion Technology', Tata McGraw Hill, 1989.
5. P.J. Lunde., Solar Thermal Engineering', John Willey & Sons, New York, 1988.

ME6234 ADVANCED CONTROL SYSTEMSENGINEERING Cr-3

Non-linear control systems:
Introduction to non-linear system, nonlinear control system, Describing functions, describing function analysis to non-linear control systems**.** **5 hrs**

Optimal control Theory
Performance indices, Formulation of optimization problems, time optimal control systems, Time optimal control for continuous time system with bounded control signals, time optimal control for discrete time system. **6 hrs**

Optimal control system based on quadratic performance indices. Calculus of variations, applications of optimal control to dynamic systems. Pontryagin minimum principle and its application to optimal control problems with constraints

6 hrs

Dynamic Programming, Bellman- Jacobi equation and its applications, introduction to optimal control of distributed parameter system. Solution algebraic Ricattii's equation for linear regulator problem. **6 hrs**

Stochastic control, limitation of deterministic control and processes, Probability and axioms: Definitions, axioms and probability, conditional probability **3 hrs**

Repeated Trails: Combined experiments, Bernoulli trails, asymptotic theorems, poison theorem, Bay's theorem and statistics **4 hrs**

Random Variables: Distribution and density function, conditional distributions, total probability and Bay's theorem, mean and variance, moments characteristics functions, two random variables, moments and conditional statistics. Stationary processes, system with stochastic inputs, Periodicity, correlation and spectra. **6 hrs**

***Text Books*:**

1. I. Populis, "Probability, Random Variables and stochastic process", McGraw Hill, 1996.

***Reference Books*:**

1. J.E. Gibson, "Non Linear Control System", McGraw Hill, 1963
2. D. E. Kirk, "Optimal Control Theory", Dover Publications, 2004.

ME6235 ENVIRONMENTAL POLLUTION AND CONTROL Cr-3

Air Pollution: Classification and properties of air pollutants, sampling and analysis of air pollutants, control of air pollution. **6 Hrs**

Dispersion of Air Pollutants: Gaussian plume model, control of gaseous pollutants, volatile organic compounds, control of gaseous emission, air pollution laws and standards. **8 Hrs**

Water Pollution: Sampling and analysis of waste treatment advanced waste water treatments by physical, chemical, biological and thermal methods, effluent quality standards. **8 Hrs**

Solid Waste Management: Classification and their sources, health hazards, handling of toxic and radioactive wastes, incineration and verification. **8 Hrs**

Pollution Control in Process Industries: Cement, Paper, Petroleum and petrochemical, Fertilizers and distilleries, thermal power plants and automobiles. **6 Hrs**

Text Book:

1. *Introduction to Environmental Engineering and Science,* Manster, G.M., 2nd ed., Pearson Publishers, 2004.

Reference Books:

1. *Environmental Pollution Control Engineering,* E.S. Rao, Wiley Eastern Ltd., 1991.

2. *Pollution Control in Process Industries,* S.P. Mahajan, Tata McGraw-Hill, 1985.

3. *Air Pollution Control Theory,* M. Crawford, TMH, 1976

ME6236 CRYOGENIC ENGINEERING Cr-3

Cryogenic Systems: Properties of Cryogenic fluids, Material properties at Cryogenic Temperatures. Carnot Liquefaction Cycle, F.O.M. and Yield of Liquefaction Cycles. Inversion Curve - Joule Thomson Effect. **10 hrs**

Liquefaction Cycles: Linde Hampson Cycle, Precooled Linde Hampson Cycle, Claudes Cycle, Collins Cycle, Dual Pressure Cycle, Helium Regrigerated Hydrogen Liquefaction Systems. Critical components in Liquefaction Systems, Introduction to air separation. **10 hrs**

Cryogenic Refrigerators: J.T. Cryocoolers, Stirling Cycle Refrigerators, G.M. Cryocoolers, Pulse Tube Refrigerators, Regenerators used in Cryogenic Refrigerators, Magnetic Refrigerators **6 hrs**

Storage and transfer of Cryogenic liquids, Design of storage vessels. **3 hrs**

Cryogenic Insulation, Multi-layer insulation, Vacuum insulation etc**.** **3 hrs**

Applications: Applications of Cryogenics in Space Programmes, Superconductivity, Cryo Metallurgy, Medical applications**.** **4 hrs**

***Text Books*:**
1. K. D.Timmerhaus and T.M. Flynn, Cryogenic Process Engineering, Plenum Press, 1989.

***Reference Books*:**
1. R. F. Barron, Cryogenic Systems, McGraw Hill, 1985.
2. R.B.Scott, Cryogenic Engineering, Van Nostrand and Co., 1962.
3. H. Weinstock, Cryogenic Technology, 1969.
4. R.W. Vance, Cryogenic Technology, John Wiley & Sons, Inc., New York, London, 1963.

ME6237 ADVANCED POWER PLANT ENGINEERING Cr-3

Review of Conventional Power Plants: Limitations, trends of modern power generation, environmental issues, combined power plants. **4 Hrs**

Coal Gasification: Plants with coal gasification, high temperature fuel cells, fuel cell integrated systems, other plants, parametric analysis, performance estimation, retrofitting of old plants, case studies. **8 Hrs**

Nuclear Power Engineering: Basic concepts of reactor physics, radioactivity, neutron scattering, thermal and fast reactors, nuclear cross-sections, neutron flux and reaction rates, moderator criteria. **6 Hrs**

Reactor Core Design: Conversion and breeding, types of reactors, characteristics of boiling water, pressurized water, pressurized heavy water, gas cooled and liquid metal cooled reactors. **4 Hrs**

Heavy Water Management: Containment system for nuclear reactor, reactor safety radiation shields, waste management, Indian nuclear power programme. **4 Hrs**

Solar Power Engineering: Fundamental principles of solar radiation, handling of solar radiation data, thermal analysis of flat plate collectors, performance test of flat plate collectors, concentrating collectors. **6 Hrs**

System Sizing by F-chart: Utilizability method, economics of solar energy, application of solar thermal energy to cooling, drying and distillation, storage of solar energy, solar ponds. **4 Hrs**

Text Book:

1. *Nuclear Power Engineering*, M. M. EI. Wakil, McGraw Hill Book Company, New York, 1987.

Reference Books:

1. *Nuclear Reactors Engineering*, S. Glasstone and A. Setonske., 3rd Ed., CBS Publishers and Distributors, 1992.

2. *Nuclear Power Plants*, Loftness, D. Van Nostrand Company Inc, Princeton, 1964.

3. *Physics of Nuclear Reactors*, S. Sarg et al., Tata McGraw Hill Publishing Company Ltd., 1985.

4. *Fundamentals of Nuclear Energy*, T. J. Connoly., John Wiley, 1978.

ME6238 ARTIFICIAL INTELLIGENCE Cr-3

Neural Networks-I (Introduction & Architecture)
Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, **3 hrs**
Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory. **7 hrs**

Neural Networks-II (Back propogation networks)
Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting backpropagation training, applications. **6 hrs**

Fuzzy Logic-I (Introduction)
Basic concepts of fuzzy logic, Fuzzy sets and Crisp sets, Fuzzy set theory and operations, Properties of fuzzy sets, Fuzzy and Crisp relations, Fuzzy to Crisp conversion. **6 hrs**

Fuzzy Logic –II (Fuzzy Membership, Rules)
Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications. **8 hrs**

Genetic Algorithm (GA)
Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, applications. **6 hrs**

***Text Books*:**

1. Jyh Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, *Neuro-Fuzzy and Soft Computing: An Computational Approach to Learning and Machine*, Prentice Hall. 1997

***Reference Books*:**

1. Chin –Teng Lin and C.S. George Lee, Neural Fuzzy Systems" – A neuro fuzzy synergism to Intelligent systems, Prentice Hall International. 1996
2. Yanqing Zhang and Abraham Kandel, Compensatory Genetic Fuzzy Neural Networks and Their Applications, World Scientific. 1998.
3. T. J. Ross, Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc. 1995.
4. S. Rajsekaran & G.A. Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis and Applications" Prentice Hall of India, 2003.
5. N.P.Padhy,"Artificial Intelligence and Intelligent Systems" Oxford University Press, 2005.

SCHOOL OF MECHANICAL ENGINEERING

SPECIALIZATION: MACHINE DESIGN

ME6301 THEORY OF ELASTICITY AND PLASTICITY Cr-4

Elasticity-I: Introduction, Definition of stress and strain at a point, components of stress and strain at a point in Cartesian and polar co-ordinates, constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases. Transformation of stress and strain at a point, Principal stresses and principal strains, invariants of stress and strain, hydrostatic and deviatoric stress, spherical and deviatoric strains, max. shear stress, max. Shear strain. Plain stress and plain strain: Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams. Solution of axi-symmetric problems, stress concentration due to the presence of a circular hole in planes. **14 Hrs**

Elasticity-II: Elementary problems of elasticity in three dimensions, stretching of a prismatical bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, Propagation of waves in solid media. Applications of finite difference equations in elasticity. **11 Hrs**

Plasticity-I: Stress-strain diagram in simple tension, perfectly elastic, Rigid - Perfectly plastic, Linear work - hardening, Elastic Perfectly plastic, Elastic Linear work hardening materials, Failure theories, yield conditions, stress - space representation of yield criteria through Westergard stress space, Tresca and Von-Mises criteria of yielding. **12 Hrs**

Plasticity-II: Plastic stress-strain relations, Saint Venant's Theory of Plastic flow, Elastic plastic Deformations, Prandtl's stress equations, Levy - Mises equation, Reuss theory of elastic - plastic deformation, Hencky's theory of small plastic deformations, Plastic potential, Flow Rule. **11 Hrs**

Text Books:

1. Timoshenko and Goodier, Theory of elasticity, McGraw Hill Book Company, III Edition, 1983.
2. J. Chakrabarthy, Theory of Plasticity, McGraw Hill, 1987.

Reference Books:

1. W. Johnson and P. B. Mellor, Plasticity for Mechanical Engineers, D.Van Nostrand Co. Ltd., 1962.
2. Oscar Haffman and George Sachs, Introduction to the Theory of Plasticity for Engineers, Mc, Graw Hill co, 2012.
3. C. N. Massonnet, Plastic Analysis and Design of Plates, Shells and Discs, North Holland Publishing Co.
4. M. Kachanov, Theory of Plasticity, Mir publishers, Moscow, 2011.

ME6302 ENGINEERING TRIBOLOLGY Cr-4

Introduction: Defining Tribology, Tribology in Design - Mechanical design of oil seals and gasket - Tribological design of oil seals and gasket, Tribology in Industry (Maintenance), Defining Lubrication, Basic Modes of Lubrication, Properties of Lubricants, Lubricant Additives, Defining Bearing Terminology - Sliding contact bearings - Rolling contact bearings, Comparison between Sliding and Rolling Contact Bearings. **7 Hrs**

Friction & Wear: Laws of friction - Friction classification - Causes of friction, Theories of Dry Friction, Friction Measurement, Stick-Slip Motion and Friction Instabilities, Wear - Wear classification - Wear between solids - Wear between solid and liquid - Factors affecting wear - Measurement of wear, Theories of Wear, Approaches to Friction Control and Wear Prevention, Boundary Lubrication, Bearing Materials and Bearing Construction. **8 Hrs**

Bearing Lubrication: Mechanics of Fluid Flow, Theory of hydrodynamic lubrication, Mechanism of pressure development in oil film, Two Dimensional Reynolds's Equation and its Limitations, Idealized Bearings, Infinitely Long Plane Fixed Sliders, Infinitely Long Plane Pivoted Sliders, Infinitely Long Journal Bearings, Infinitely Short Journal Bearings, Designing Journal Bearing, Sommerfeld number, Raimondi and Boyd method, Petroff's Solution, Parameters of bearing design, Unit pressure, Temperature rise, Length to diameter ratio , Radial clearance, Minimum oil-film thickness. **8 Hrs**

Hydrodynamic Thrust Bearing: Introduction - Flat plate thrust bearing - Tilting pad thrust bearing, Pressure Equation - Flat plate thrust bearing - Tilting pad thrust bearing, Load - Flat plate thrust bearing - Tilting pad thrust bearing, Center of Pressure - Flat plate thrust bearing - Tilting pad thrust bearing, Friction - Flat plate thrust bearing - Tilting pad thrust bearing. **7 Hrs**

Hydrostatic Lubrication: - Basic concept - Advantages and limitations - Viscous flow through rectangular slot - Load carrying capacity and flow requirement - Energy losses - Optimum design, Squeeze Film Lubrication - Basic concept - Squeeze action between circular and rectangular plates - Squeeze action under variable and alternating loads, Application to journal bearings, Piston Pin Lubrications. **6 Hrs**

Elasto-Hydrodynamic Lubrication: Principles and Applications, Pressure viscosity term in Reynolds's equation, Hertz's Theory, Ertel-Grubin equation, Lubrication of spheres, Gear teeth bearings, Rolling element bearings. **6 hrs**

Gas lubricated Bearings: Introduction, Merits, Demerits and Applications, Tilting pad bearings, Magnetic recording discs with flying head, Hydrostatic bearings with air lubrication, Hydrodynamic bearings with air lubrication, Thrust bearings with air lubrication. **6 Hrs**

Text Books:

1. B C Majumdar, 1999, "Introduction to Tribology of Bearings", A. H. Wheeler & Co. Ltd., New Delhi.

Reference Books:

1. Pinkus, O. and Sternlicht, B., 1961, "Theory of hydrodynamic lubrication", Mc Graw Hill Book Co. Inc., New York.
2. A Cameron and C.M. Mc Ettles, 1987, "Basic Lubrication Theory", Wiley Eastern Ltd., New Delhi.

ME6303 ADVANCED MECHANICS OF SOLIDS AND STRUCTURES Cr-4

Analysis of Stresses and Strains in rectangular and polar coordinates: Cauchy's formula, Principal stresses and principal strains, 3D Mohr's Circle, Octahedral Stresses, Hydrostatic and deviatoric stress. **10 Hrs**

Stress-strain relations for linearly elastic solids: Differential equations of equilibrium, Plane stress and plane strain, compatibility conditions. Introduction to curvilinear coordinates. Generalized Hooke's law and theories of failure. Energy Methods. **10 Hrs**

Bending of straight/curved beams and shear centre: Effect of shear stresses, Curved beams, Shear center and shear flow, shear stresses in thin walled sections, thick curved bars. Torsion of prismatic solid sections, thin walled sections, circular, rectangular and elliptical bars, membrane analogy. **18 Hrs**

Axisymmetric Problems: Thick and thin walled cylinders, Composite tubes, Rotating disks and cylinders. Euler's buckling load, Beam Column equations. Strain measurement techniques using strain gages, characteristics, instrumentations, principles of photo-elasticity. **10 Hrs**

Text Books:

1. A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 5th Edition, John Willey and Sons Inc, 1993.
2. L. S. Srinath, Advanced Mechanics of Solids, 2nd Edition, TMH Publishing Co. Ltd., New Delhi, 2003.

Reference Books:

1. R. G. Budynas, Advanced Strength and Applied Stress Analysis, 2nd Edition, McGraw Hill Publishing Co, 1999.
2. A. P. Boresi, R. J. Schmidt, Advanced Mechanics of Materials, 5th Edition, John Willey and Sons Inc, 1993.
3. S. P. Timoshenko, J. N. Goodier, Theory of Elasticity, 3rd Edition, McGraw Hill Publishing Co. 1970.
4. P. Raymond, Solid Mechanics for Engineering, 1st Edition, John Willey & Sons, 2001.

ME6304 FINITE ELEMENT METHOD Cr-4

Introduction: Concept of FEM, History, Packages, Range of applications, Steps in FEM, Approaches of FEM, Development of Elemental Equations for simple systems, Two DOF problems- Plane Trusses and Frame structures; Assembly Procedure, Application of Boundary Conditions; Solver Technology: Linear direct solver, Iterative solvers, Eigen solver, Non-linear equation solver. **12 Hrs**

One dimensional problems: Governing Equation and Boundary Conditions for Solid Mechanics-Bar extension and Beam bending; Weak Formulation and Functional, Polynomial Approximation, Standard 1-D Shape Functions of continuity elements, Derivation of Element Matrices and Vectors, Assembly, Imposition of Boundary Conditions and Nodal Solution; Co-ordinate Transformation and Numerical Integration. **12 Hrs**

Two dimensional problems: Governing Equation and Boundary Conditions-Solid mechanics-Rod Torsion, Fluid Dynamics-Stream function, Weak Formulation and Functional, Polynomial Approximation, Standard 2-D Shape Functions of continuity elements, Derivation of Element Matrices and Vectors, Assembly, Imposition of Boundary Conditions and Nodal Solution; Mapping and Numerical Integration; Transient and Eigen Value Problems. **12 Hrs**

Three dimensional problems: Governing equation and Boundary Conditions, Weak Formulation and Functional, Polynomial Approximation, Standard 3-D Shape Functions of Continuity Elements, Derivation of Element Matrices and Vectors, Assembly, Imposition of boundary conditions and Nodal Solution; Mapping and Numerical Integration. **12 Hrs**

Text Books:

1. Finite Element Methods -S.S. Rao, Elesevier, 2013.
2. P. Sheshu, Text book of finite element analysis, PHI, 2005.

Reference Books:

1. O. C. Zienkiewicz, The Finite Element Method in Engg Science, Ed, Wiley & Sons.2013.
2. S. Lary, Applied Finite Element Analysis, John Wiley, 2008.

ME6305 NOISE AND VIBRATION CONTROL ENGINEERING Cr-4

Multi degrees of freedom systems: Generalised co-ordinates, constraints, virtual work; Hamilton's principle, Lagrange's equations; Discrete and continuous system; Vibration absorbers; Response of discrete systems - SDOF & MDOF: Free-vibration, periodic excitation and Fourier series, impulse and step response, convolution integral. **12 Hrs**

Continuous systems: Modal analysis: undamped and damped non-gyroscopic, undamped gyroscopic and general ynamical systems. Effect of damping; Vibration of strings, beams, bars, membranes and plates, free and forced vibrations; Raleigh-Ritz and Galerkin's methods. Measurement techniques. **12 Hrs**

Basics of noise engineering: Principles of sound generation and propagation, sound attenuation, sound absorption, sources of industrial noise, effects of noise, noise measurement units and instruments, identification of source of noise. **12 Hrs**
Noise Control: Noise evaluation procedures, acoustical enclosures, design of reactive and absorptive mufflers, active noise control, designing for quieter machines and processes, case studies. **12 Hrs**

Texts Books:

1. Vibration and Acoustics by C. Sujatha, TMH, 2009.

Reference Books:

1. F S Tse, I E Morse and R T Hinkle, Mechanical Vibrations, CBS Publ., 1983.
2. J S Rao and K Gupta, Theory and Practice of Mechanical Vibrations, New Age Publication, 1995
3. Harold Lord, Gatley and Eversen, Noise Control for Engineers, McGraw-Hill, 1987.
4. R. H. Lyon, Machinery Noise and Diagnostics, Butterworths, 1987. 5. J. W. Dally and W.

ME6306 ANALYSIS & PERFORMANCE OF COMPOSITE MATERIALS Cr-4

Introduction: Fibers, Matrices, Classifications, Particulate and Fabrication of composites, matrix materials. **8 Hrs**

Behavior of Unidirectional composites: Longitudinal behavior of unidirectional composites, transverse stiffness and strength, prediction of shear modulus, prediction of Poission's ratio, failure modes, expansion coefficients and transport properties. **9 Hrs**

Analyses of Orthotropic Lamina: Stress-strain relations and engineering constants, Hooke's Law and stiffness and compliance matrices, strength of an orthotropic lamina. **7 Hrs**

Analyses of Laminated composites: Laminate strains, laminate description system, determination of laminate stresses and strains, analysis of laminates after initial failure. **8 Hrs**

Performance of Fibre Composites: Fatigue damage, factors influencing fatigue behavior of composites, impact, energy absorbing mechanisms and failure models, effect of materials and testing variables on impact properties, hybrid composites and their impact strength, environmental-interaction effects. **8 Hrs**

Experimental characterization of Composites: Measurement of physical properties, Measurement of mechanical properties, inter-laminar shear strength and fracture toughness. **8 Hrs**

Text Books:

1. Analysis and performance of Fiber Composites- B.D. Agarwal, L.J. Broutman, K.Chandrasekhar, Wiley

Reference Books:

1. *Engineering Mechanics of Composite Materials-I.M.Daniel and Ori Ishai, Oxford University press, 2011.*

ME6321 FATIGUE AND FRACTURE BASED DESIGN Cr-3

Modes of failure: Types of failure, Brittle and ductile fracture, Modes of fracture failure, Griffith's theory of brittle fracture, Energy release rate, Energy release rate of DCB specimen. **5 Hrs**

Linear elastic analysis of cracked bodies: Deformation at crack tip, Crack resistance, Stable and unstable crack growth, R-curves for brittle cracks, critical energy release rate. **5 Hrs**

Linear elastic fracture mechanics (LEFM): Stress intensity factor, Fracture toughness, Stress distribution at crack tip, Plane stress and plane strain cases. **5 Hrs**

Crack tip plasticity: plastic zone size due to Irwin, plastic zone size due to Dugdale, plastic zone shape using classical yield criteriaplane strain fracture toughness. **8 Hrs**

Elastic plastic analysis: Introduction, the J-integral, path independence of J-integral. **5 Hrs**

Fatigue crack growth: Types of fatigue loading, Fatigue test methods, Endurance limit and S-N diagram, Factors influencing fatigue strength, Influence of stress concentration, Crack initiation and propagation, effect of an overload, Crack closure, Fatigue life calculations, methods of increasing fatigue life, Test methods to determine K_{Ic}. **8 Hrs**

Text Books:

1. T L Anderson, Fracture Mechanics: Fundamentals and Applications, CRC Press, 2004.

2. S Suresh, Fatigue of Materials, Cambridge University Press, 1998.

Reference Books:

1. P. Kumar, Elements of Fracture Mechanics, Wheeler Publishing, 2009.

2. K. Hellan, Introduction to Fracture Mechanics, McGraw-Hill, 1984.

ME6322 ANALYAIS OF FUNCTIONALLY GRADED MATERIALS Cr: 3

Modeling of Functionally Graded Materials and Structures: Effective Material Properties of FGMs, Reddy's Higher Order Shear Deformation Plate Theory, Generalized Kármán-Type Nonlinear Equations . **6 Hrs**

Nonlinear Bending of Shear Deformable FGM Plates: Nonlinear Bending of FGM Plates under Mechanical Loads in Thermal Environments, Nonlinear Thermal Bending of FGM Plates due to Heat Conduction. **6 Hrs**

Postbuckling of Shear Deformable FGM Plates: Postbuckling of FGM Plates with Piezoele ctric Actuators under Thermoelectromechanical Loads, Thermal Postbuckling Behavior of FGM Plates with Piezoelectric Actuators, Postbuckling of Sandwich Plates with FGM Face Sheets in Thermal Environments. **8 Hrs**

Nonlinear Vibration of Shear Deformable FGM Plates: Nonlinear Vibration of FGM Plates in Thermal Environments, Nonlinear Vibration of FGM Plates with Piezoelectric Actuators in Thermal Environments , Vibration of Postbuckled Sandwich Plates with FGM Face Sheets in Thermal Environments. **8 Hrs**

Postbuckling of Shear Deformable FGM Shells: Boundary Layer Theory for the Buckling of FGM Cylindrical Shells, Postbuckling Behavior of FGM Cylindrical Shells under Axial Compression, Postbuckling Behavior of FGM Cylindrical Shells under External Pressure, Postbuckling Behavior of FGM Cylindrical Shells under Torsion, Thermal Postbuckling Behavior of FGM Cylindrical Shells. **8 Hrs**

Text Books:

1. Functionally Graded Materials by J.N. Reddy, 2003.

Reference Books:

1. Functionally Graded Materials: Non linear Analysis of Plates and Shells
Hui-Sen Sen, Publisher: CRC Press (2009)

ME6323 EXPERIMENTAL STRESS ANALYSIS Cr-3

Theory of Photo-elasticity: The stress optic law in two dimensions at normal incidence, Effects of a stressed model in a plane polariscope, Effects of a plane model in a circular polariscope with dark and light field arrangements. **8 Hrs**

Analysis Techniques: Isochromatic fringe patterns, Isoclinic fringe patterns, Compensation techniques, separation techniques, Sealing model to prototype stresses. **5 Hrs**

Strain Measurement Methods: Basic characteristics of a strain gauge, Types of strain gauge, Moire method of strain analysis, Grid method of strain analysis. **5 Hrs**

Electrical Resistance Strain Gauge: Factors influencing strain sensitivity in metallic alloys, Gauge construction temperature compensation, Factors-influencing gauge section gauge sensitivity and gauge factor, Correction for transverse strain effects, Semiconductor strain gauges. Rosette analysis – three element rectangular rosette. The delta rosette, the four elements. The delta rosette, the strain gauge, Strain circuits, Potentiometer circuits, the Wheatstone bridge. **10 Hrs**

Brittle Coating Method: Coating stresses, Failure theories of brittle coating crack patterns due to direct loading, Brittle-coating crack patterns produced by refrigeration techniques, Brittle coating crack pattern produced by releasing the load, Double crack pattern, Crack detection, Load-time relation and its influence on the threshold strain effects of a biaxial stress field. **8 Hrs**

Text Books:

1. J.W. Dally and W.F. Riley, Experimental Stress Analysis, 2nd eEd. McGraw Hill.
2. K. Ramesh, Published by IIT Madras, India, Experimental Stress Analysis, 2009.

Reference Books:

1. A Mubin, Khanna Publications, Experimental Stress Analysis, 2003.
2. Sadhu Singh, Khanna Publishers, Experimental Stress Analysis, 1982.
3. Srinath , An Introduction to Experimental Stress Analysis – MGH, 1983.

ME6324 MEMS AND NEMS Cr-3

Introduction: Various components of MEMS, applications and standards, micromachining, basic process tools- epitaxy, sputtering, chemical vapor deposition and spin on methods, oxidation, evaporation, lithography and etching, advanced process tools, sol gel process, EFAB. Silicon, Silicon oxide and nitride, thin metal films, Polymers, Other materials and substrates, polycrystalline materials, mechanics of Microsystems, static bending, mechanical vibrations, thermo mechanics, fracture mechanism, fatigue, and stress and strain, young's modulus and modulus of rigidity, scaling laws in miniaturization. **15 Hrs**

Sensor and Scaling: Micro sensors (acoustic wave sensors, biomedical, chemical, optical, capacitive, pressure, thermal), micro actuators (thermal, piezoelectric, electrostatic, micrometers, micro valves & pumps, accelerometer, micro fluidics and devices), design consideration, process design and mechanical design. Mechanical system, Thermal system, Fluidic system, Electrical system scaling. Packaging of MEMS and NEMS and its design considerations. **15 Hrs**

Application: Automotive industry – health care – aerospace industrial product consumer products – lab on chip – molecular machines – data storage devices – micro reactor – telecommunications, Servo systems. **6 Hrs**

Text Books:

1. MEMS and NEMS:Systems, Devices and Structures by Sergey Edward Lyshevski, CRC Press, 2012.

Reference Books:

1. Modeling MEMS and NEMS by John A. Pelesko , David H. Bernstein, CRC Press, 2002.

ME6325 THEORY OF PLATE AND SHELLS Cr-3

Introduction: Plate and Shell Structures in Aerospace Vehicles. Flexural rigidity of plates. Flexural rigidity of shells. Introduction to bending and buckling of plates and shells. Reinforced plates. Eccentrically compressed shells. **4 Hrs**

Bending of Thin Plates –Stresses: Pure bending of plates. Isotropic and orthotropic flat plates. Flexural rigidity of plate. Bending of plates by distributed lateral load. Combined bending and tension or compression. Bending and twisting moments. Shear stress. **5 Hrs**

Bending Of Thin Plates - Strain Energy: Slopes of deflection of surface. Different edge conditions: - built in edge, simply supported edge and, free edge. Combined bending and tension or compression of plates. Strain energy by: – bending of plates, bending by lateral loads, combined bending and tension or compression of plates. **5 Hrs**

Buckling of Thin Plates: Method of calculation of critical loads. Buckling of simply supported rectangular plates uniformly compressed in one direction. Buckling of uniformly compressed rectangular plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides. Critical values of compressive stress. **5 Hrs**

Buckling of Reinforced Plates: Stability of plates reinforced by ribs. Simply supported rectangular plates with longitudinal ribs. General equation for critical compressive stress. Critical compressive stress for a plate stiffened by one rib. Study of the experimental value of buckling of plates. **5 Hrs**

Bending of Thin Shells: Deformation of an element of a shell. Expression for components of normal stresses. Flexural rigidity of shell. Case of deformation with presence of shearing stresses. **5 Hrs**

Strain Energy of Deformation of Shells: Strain energy of deformation of shell:-bending and stretching of middle surface. Symmetrical deformation of a circular cylindrical shell. Differential equation for bending of strip. **4 Hrs**

Buckling Of Shells: Symmetrical buckling of cylindrical shell under the action of uniform axial compression :-differential equation , critical stress. Symmetrical buckling of cylindrical shell under the action of uniform axial pressure. Study of the experimental values of cylindrical shells in axial compression. Bent or eccentrically compressed shells. **4 Hrs**

Text Books:

1. Theory of plates and Shells by S. Timoshenko, S.W. Krieger, McGraw Hill Publications, 2003.

Reference Books:

1. Dynamics of Plates by J.S. Rao, Narosa.

ME6326 DESIGN OPTIMIZATION Cr-3

Introduction: Morphology of design with a flow chart, Discussion on market analysis, profit, time value of money, an example of discounted cash flow technique, Concept of workable design, practical example on workable system and optimal design. **4 Hrs**

System Simulation: Classification, Successive substitution method – examples, Newton Raphson method - one unknown – examples, Newton Raphson method - multiple unknowns – examples, Gauss Seidel method – examples, Rudiments of finite difference method for partial differential equations, with an example. **8 Hrs**

Regression and Curve Fitting: Need for regression in simulation and optimization, Concept of best fit and exact fit, Exact fit - Lagrange interpolation, Newton's divided difference – examples, Least square regression - theory, examples from linear regression with one and more unknowns – examples, Power law forms – examples, Gauss Newton method for non-linear least squares regression – examples. **8 Hrs**

Optimization Introduction, Formulation of optimization problems – examples, Calculus techniques – Lagrange multiplier method – proof, examples, Search methods – Concept of interval of uncertainty, reduction ratio, reduction ratios of simple search techniques like exhaustive search, dichotomous search, Fibonacci search and Golden section search – numerical examples, Method of steepest ascent/ steepest descent, conjugate gradient method – examples, Geometric programming – examples, Dynamic programming – examples, Linear programming – two variable problem –graphical solution, New generation optimization techniques – Genetic algorithm and simulated annealing – examples, Introduction to Bayesian framework for optimization- examples. **6 Hrs**

Text Books:

1- *Engineering Optimization, S.S. Rao, New Age Publications, 2009.*

Reference Books :

1. *Design and optimization of thermal systems, Y.Jaluria, Mc Graw Hill, 1998.*
2. *Elements of thermal fluid system design, L.C.Burmeister, Prentice Hall, 1998.*
3. *Design of thermal systems, W.F.Stoecker, Mc Graw Hill, 1989.*
4. *Introduction to optimum design, J.S.Arora, Mc Graw Hill, 1989.*

ME6327 SIMULATION OF DYNAMIC SYSTEMS Cr-3

Introduction: An invariant nature of power exchange, representation of junction elements, power direction and physical system coordinates, notion of causality. **7 Hrs**

Creation of System Equation: selection of system states, bond graph with transfer element, system with differential causality, algebraic loops, creation of system bond graph. **7 Hrs**

Use of Noninertial Coordinate: principle of material objective, dynamics of rigid bodies, system with nonpotential fields. **7 Hrs**

Simolation: structural members, multi-body system, mechanical handling system, robot, thermal system, hydraulic system. **8 Hrs**

Control systems: control strategy, modelling of electronics circuit, fault detection and isolations. **7 Hrs**

Text Books:

1. Bond Graph in Modeling, Simulation and Fault Indentification by A Mukherjee, R. Karmakar, A.K. Samantaray, I.K. International Publications.

ME6328 DYNAMICS OF ROTOR Cr-3

Torsional Vibration in Rotating Systems: Modelling of rotating systems, Equivalent discreet system, branched system and gear system. **8 Hrs**

Bending Critical Speeds of Simple Shafts: Whirling of unbalanced elastic rotor, simple shaft with several disks, and Transfer matrix analysis of bending critical speeds.Out of balance response of rotors with rigid supports. **6 Hrs**

Gyroscopic Effects in Rotor system: Effect of spinning disk, synchronous whirl of an overhang rotor, Non synchronous whirl, Rotor with couplings and whirl speed analysis. **6 Hrs**

Rotor mounted on fluid film bearings: Simple rotor in fluid film bearings, Dual rotor system analysis,Optimum design for minium unbalance Instability of rotors. **6 Hrs**

Balancing of Rotors: Rigid rotor balancing criteria and balancing of flexible rotors. **6 Hrs**

Condition Monitoring: Vibration Measurements, Vibration generating mechanism, vibration spectrum real time analysis and expert system. **4 Hrs**

Text Books:

1. Rotor Dynamics by J. S. Rao, New Age Int, 2004.

Reference Books:

1. Rotor Dynamics by Agnieszka Muszynska*, CRC Press*

ME6329 THEORY OF ADVANCED MECHANISMS AND MACHINES Cr-3

Review of Kinematic synthesis: Graphical and analytical methods, two and three precision point synthesis. Function, Path and motion generation by 4-bar linkage: four and five precision point synthesis. **10 Hrs**

Synthesis of planer mechanisms: Geared linkages, path and motion generation by Watt and Stephenson's six- bar chain, precision point synthesis Vis a vis optimization methods. Newton-Raphson solution Method for fourbar linkage. **10 Hrs**

Synthesis of spatial mechanisms: displacement analysis, matrix method of analysis, Synthesis of 4 – revolute spherical mechanisms, synthesis of 2- revolute 2 spheric- pair mechanisms. **10 Hrs**

Application to robotics: Manipulator Dynamics and Controls, Computer-Aided Methods for setting and solving Mathematical models of active mechanisms. **6 Hrs**

Text Books:

1. Norton, R.L., 1999, "Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and machines", 2nd Ed., WCB McGraw-Hill.

Reference Books:

1. Hartenberg, R.S., Denavit, J., 1964, "Kinaematic Synthesis of Linkages", McGraw- Hill, New York, 1964.
2. Sandor, G.N., Erdman, A.G., 1984"Advanced Mechanism Design Analysis and Synthesis", Vol. - 1, Prentice-Hall, New Jersey.

ME6331 ADVANCED CONTROL THEORY Cr-3

Introduction to control problems: Industrial Control examples. Transfer function models of mechanical, electrical, thermal and hydraulic systems. System with dead-time.System response. Control hardware and their models: potentiometers, synchros, LVDT, dc and ac servomotors, tachogenerators, electro hydraulic valves, hydraulic servomotors, electropeumatic valves, pneumatic actuators. Closed-loop systems. Block diagram and signal flow graph analysis, transfer function. **7 Hrs**

Basic characteristics of feedback control systems: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. Basic modes of feedback control: proportional, integral and derivative. Feed-forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion. Time response of second-order systems, steady-state errors and error constants.Performance specifications in time-domain. Root locus method of design. Lead and lag compensation. **10 Hrs**

Frequency-response analysis: Relationship between time & frequency response, Polar plots, Bode's plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion.Performance specifications in frequency-domain.Frequency-domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Op-amp based and digital implementation of compensators. Tuning of process controllers.State variable formulation and solution. **8 Hrs**

State variable Analysis: Concepts of state, state variable, state model, state models for linear continuous time functions, diagonalization of transfer function, solution of state equations, concept of controllability &observability. **5 Hrs**

Introduction to Optimal control & Nonlinear control Optimal Control problem, Regulator problem, Output regulator, treking problem. Nonlinear system – Basic concept & analysis. **6 Hrs**

Text Books:

1. Gopal. M., "Control Systems: Principles and Design", Tata McGraw-Hill, 1997

Reference Books:

1. Kuo, B.C., "Automatic Control System", Prentice Hall, sixth edition, 1993.

2. Ogata, K., "Modern Control Engineering", Prentice Hall, second edition, 1991.3. Nagrath&Gopal, "Modern Control Engineering", New Ages International.

ME6332 THEORY OF NON-LINEAR VIBRATION AND SHOCK Cr-3

Introduction: Mechanical vibration: Linear nonlinear systems, types of forces and responses, Conservative and non conservative systems, equilibrium points, qualitative analysis, potential well, centre, focus, saddle-point, cusp point, Commonly observed nonlinear phenomena: multiple response, bifurcations, and jump phenomena. **4 Hrs**

Development of nonlinear governing equation of motion: Force and moment based approach, Lagrange Principle, Extended Hamilton's principle, Multi body approach, Linearization techniques, Development of temporal equation using Galerkin's method for continuous system, Ordering techniques, scaling parameters, book-keeping parameter. Commonly used nonlinear equations: Duffing equation, Van der Pol's oscillator, Mathieu's and Hill's equations. **7 Hrs**

Approximate solution method: Harmonic balance, perturbation techniques (Linstedt-Poincare', method of Multiple Scales, Averaging – Krylov-Bogoliubov-Mitropolsky), incremental harmonic balance, modified Lindstedt Poincare' techniques. **6 Hrs**

Stability and bifurcation analysis: static and dynamic bifurcations of fixed point and periodic response, different routes to chaotic response (period doubling, torus break down, attractor merging etc.), crisis. **6 Hrs**

Numerical techniques: time response, phase portrait, FFT, Poincare' maps, point attractors, limit cycles and their numerical computation, strange attractors and chaos; Lyapunov exponents and their determination, basin of attraction: point to point mapping and cell to cell mapping, fractal dimension. **7 Hrs**

Application: Single degree of freedom systems: Free vibration-Duffing's oscillator; primary-, secondary-and multiple-resonances; Forced oscillations: Van der Pol's oscillator; parametric excitation: Mathieu's and Hill's equations, Floquet theory; effects of damping and nonlinearity. Multi degree of freedom and continuous systems. **6 Hrs**

Text Books:

1. *J S Rao and K Gupta*, *Theory and Practice of Mechanical Vibrations*, *New Age Publication, 1995*

Reference Books:

1. *Nayfeh, A. H., and Mook, D. T., Nonlinear Oscillations, Wiley-Interscience, 1979.*
2. *Hayashi, C. Nonlinear Oscillations in Physical Systems, McGraw-Hill, 1964.*
3. *Evan-Ivanowski, R. M., Resonance Oscillations in Mechanical Systems, Elsevier, 1976.*
4. *Nayfeh, A. H., and Balachandran, B., Applied Nonlinear Dynamics, Wiley, 1995.*
5. *Seydel, R., From Equilibrium to Chaos: Practical Bifurcation and Stability Analysis, Elsevier, 1988.*
6. *Moon, F. C., Chaotic & Fractal Dynamics: An Introduction for Applied Scientists and Engineers, Wiley, 1992.*

ME6334 SOFT COMPUTING AND OPTIMIZATION TECHNIQUES Cr-3

Introduction: Evolution of Computing - Soft Computing Constituents – Conventional AI to Computational Intelligence - Machine Learning Basics. **5 Hrs**

Neural Networks: Machine Learning Using Neural Network - Adaptive Networks – Feed forward Networks – Supervised Learning Neural Networks – Radial Basis Function Networks - Reinforcement Learning – Unsupervised Learning Neural Networks – Adaptive Resonance architectures – Advances in Neural networks. **8 Hrs**

Fuzzy Logic: Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions- Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making. **6 Hrs**

Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modelling – Classification and Regression Trees – Data Clustering Algorithms – Rule base Structure Identification – Neuro-Fuzzy Control – Case studies. **5 Hrs**

Genetic Algorithms: Introduction to Genetic Algorithms – Applications of GA in Machine Learning - Machine Learning Approach to Knowledge Acquisition – Reproduction – Crossover – Mutation. **5 Hrs**

Unconstrained Optimization: Optimizing Single-Variable Functions, conditions for Local Minimum and Maximum, Optimizing Multi-Variable Functions. **3 Hrs**

Constrained Optimization: Optimizing Multivariable Functions with Equality Constraint: Direct Search Method, Lagrange Multipliers Method, Constrained Multivariable Optimization with inequality constrained: Kuhn-Tucker Necessary conditions. **4 Hrs**

Text Books:

1. Soft Computing by D.K. Pratihar, Narosa Publications, 2013.

Reference Books:

1. Soft computing by K. Vinoth Kumar, S.K. Kataria and Sons, 2006.

2. Neural Network- A class room approach by Satish kumar, McGraw Hill, 2004.

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