

**COMSATS Institute of Information Technology
Registrar Office, Principal Seat, Islamabad**

No: CIIT-Reg/Notif- 104 /12/149

January 25, 2012

Notification

It is hereby notified that the Board of Advanced Studies and Research in its 13th meeting held on September 26, 2011, approved the following Scheme of Studies of Doctor of Philosophy in Electrical Engineering effective from Fall 2010 and onwards admissions at CIIT System:

	<u>No. of Courses</u>	<u>Credit Hours</u>
1. PhD Course Work (List attached)	06	18
2. PhD Thesis		09
3. Graduate Regulations*		
a) Minimum duration for completion of the program is 03 years.		
b) The scholar can register a minimum of 03 credit hours and maximum of 12 credit hours in a semester at PhD level.		
c) The registration of PhD thesis of 09 credit hours will be after the completion of coursework of PhD.		
d) Relevant Graduate Rules and Regulations shall be applicable.		

This issues with the approval of the Competent Authority and supersedes Notifications No. CIIT/DGS-11/3348/10 dated January 01, 2011 and CIIT-Reg/Notif-558/11/1331 dated September 19, 2011.


Muhammad Hanif
Deputy Registrar

Encl: (Pages 55 including this page)

Distribution:

1. Dean, Faculty of Engineering, CIIT
2. Dean of Research, Innovation and Commercialization (DORIC), CIIT
3. All Directors CIIT System.
4. Chairman, Department of Electrical Engineering, CIIT
5. All Incharges, Academic Sections, CIIT Campuses
6. All HoD's/Incharges, Department of Electrical Engineering, CIIT Campuses
7. Controller of Examinations, CIIT
8. All Incharges, Examination Departments, CIIT Campuses.
9. GM(IT), CIIT Islamabad Campus for uploading on Web under "Graduate Handbook" Portal.
10. AR(Exams) for coordination with GM(IT).

CC:

1. Registrar, CIIT
2. PS to Rector

* Graduate Regulations (a to d) amended by BASAR from time to time shall be applicable.

List of Courses

S. No.	Course Code	Course Title	Credit Hrs
1	ETN610	Electromagnetic Field Theory	3(3, 0)
2	ETN611	Microwave Passive Devices and Circuits	3(3, 0)
3	ETN612	Microwave Active Devices and Circuits	3(3, 0)
4	ETN613	Introduction to RF Front-End Design	3(3, 0)
5	ETN614	RF System Engineering and Design	3(3, 0)
6	ETN615	RF Filter Design	3(3, 0)
7	ETN616	Radio Engineering	3(3, 0)
8	ETN620	Antennas Theory, Design and Applications	3(3, 0)
9	ETN621	Radio Wave Propagation	3(3, 0)
10	ETN622	RF Propagation and Planning for Wireless Communications	3(3, 0)
11	ETN630	Radar Systems	3(3, 0)
12	ETN631	Satellite Communications	3(3, 0)
13	ETN632	GPS and Navigation Systems	3(3, 0)
14	ETN640	Communication Systems Engineering	3(3, 0)
15	ETN641	Digital Communications	3(3, 0)
16	ETN642	Information Theory and Coding	3(3, 0)
17	ETN643	Communication Signal Processing	3(3, 0)
18	ETN644	Wireless Communication Techniques	3(3, 0)
19	ETN650	Communication Electronics Design	3(3, 0)
20	ETN651	Embedded System Design for Telecommunications	3(3, 0)
21	ETN660	Digital Telephony	3(3, 0)
22	ETN661	Telecommunication Switching Systems	3(3, 0)
23	ETN662	Performance Analysis of Communication Systems	3(3, 0)
24	ETN663	Telecommunication Network Management	3(3, 0)
25	ETN664	Optical Fiber Networks	3(3, 0)
26	ETN665	Communication System Design	3(3, 0)
27	ETN670	Communication Networks-Architectures and Protocols	3(3, 0)
28	ETN671	Data Networks and Communications	3(3, 0)
29	ETN672	Queuing Theory for Performance Modeling	3(3, 0)
30	ETN673	Graph Theory and Network Optimization	3(3, 0)
31	ETN674	Network Management and Operational Network Security	3(3, 0)
32	ETN675	Internet Architectures and Protocols	3(3, 0)
33	ETN676	Internetworking: Architectures, Protocols and Applications	3(3, 0)
34	ETN677	Internet Applications and Services	3(3, 0)
35	ETN678	Design of Computer Communication Networks	3(3, 0)

36	ETN679	Interconnection Networks	3(3, 0)
37	ETN680	Wireless Networks	3(3, 0)
38	ETN681	Mobile Cellular Systems and Standards	3(3, 0)
39	ETN682	Mobile and Broadband Networks	3(3, 0)
40	ETN683	Wireless LANs	3(3, 0)
41	ETN684	Mobile Applications and Services	3(3, 0)
42	ETN685	Mobile Communication Systems	3(3, 0)
43	ETN686	Wireless Sensor Networks	3(3, 0)
44	ETN710	Electromagnetic Interference and Compatibility	3(3, 0)
45	ETN711	Numerical and Computational Techniques in Electromagnetics	3(3, 0)
46	ETN712	Microwave Integrated Circuits	3(3, 0)
47	ETN713	RF and Microwave Measurement Techniques	3(3, 0)
48	ETN720	Smart Antennas for Mobile Communications	3(3, 0)
49	ETN730	Radar Signal Processing	3(3, 0)
50	ETN731	Modern Radar Systems	3(3, 0)
51	ETN740	Advanced Communication Systems Engineering	3(3, 0)
52	ETN741	Advanced Digital Communications	3(3, 0)
53	ETN742	Advanced Information Theory and Coding	3(3, 0)
54	ETN743	Adaptive Techniques for Wireless Communications	3(3, 0)
55	ETN744	Advanced Wireless Communications	3(3, 0)
56	ETN745	Advanced Channel Coding Techniques	3(3, 0)
57	ETN746	Channel Estimation and Characterization	3(3, 0)
58	ETN747	Communication Channel Modeling	3(3, 0)
59	ETN748	Wireless Channel Modeling	3(3, 0)
60	ETN750	Advanced Integrated Circuits for Communication	3(3, 0)
61	ETN760	Teletraffic Engineering	3(3, 0)
62	ETN761	Broadband Network Architectures	3(3, 0)
63	ETN762	Broadband Access Networks	3(3, 0)
64	ETN763	Telecommunication Software Design	3(3, 0)
65	ETN764	Modeling and Analysis of Telecommunication Networks	3(3, 0)
66	ETN765	Transport and Switching Technologies	3(3, 0)
67	ETN766	Short-Range Communication Systems	3(3, 0)
68	ETN767	Mobile Computing	3(3, 0)
69	ETN770	IP Routing Protocols and Internetwork Design	3(3, 0)
70	ETN771	Advanced Network Programming	3(3, 0)
71	ETN772	Networks and Computer Security	3(3, 0)
72	ETN773	Performance Evaluation of Computer Networks	3(3, 0)
73	ETN774	Cryptography and Secure Communication	3(3, 0)
74	ETN775	IP Telephony	3(3, 0)

75	ETN776	Design and Analysis of Computer Communication Networks	3(3, 0)
76	ETN777	Multimedia Networking	3(3, 0)
77	ETN778	Network Programming Techniques	3(3, 0)
78	ETN779	High-Speed Switched Local Area Networks (LANs)	3(3, 0)
79	ETN780	RF Network Planning and Design	3(3, 0)
80	ETN781	Emerging Wireless Networks	3(3, 0)
81	ETN782	QoS Architectures for Multimedia Wireless Networks	3(3, 0)
82	ETN783	Mobile Devices Applications Development	3(3, 0)
83	ETN784	Mobile Networking	3(3, 0)
84	ETN785	Wireless Medium Access Techniques	3(3, 0)
85	ETN786	Wireless Wide Area Networks (WWANs)	3(3, 0)
86	ETN787	Wireless Metropolitan Area Networks (WMANs)	3(3, 0)
87	ETN788	Wireless Personal and Body Area Networks (WPANs/WBANs)	3(3, 0)
88	ETN810	Advanced Topics in RF System Design	3(3, 0)
89	ETN811	Advanced Topics in RF/Microwave Engineering	3(3, 0)
90	ETN820	Advanced Topics in Antenna Design	3(3, 0)
91	ETN821	Advanced Topics in Radio Wave Propagation	3(3, 0)
92	ETN822	Advanced Topics in RF Planning and Optimization	3(3, 0)
93	ETN840	Special Topics in Communication Systems	3(3, 0)
94	ETN841	Advanced Topics in Communications Theory	3(3, 0)
95	ETN842	Advanced Topics in Communication Signal Processing	3(3, 0)
96	ETN843	Advanced Topics in Wireless Communications	3(3, 0)
97	ETN844	Advanced Topics in Information Theory and Coding	3(3, 0)
98	ETN845	Advanced Topics in Error Control Coding	3(3, 0)
99	ETN846	Advanced Topics in Information Security	3(3, 0)
100	ETN850	Advanced Topics in Telecommunication Electronics	3(3, 0)
101	ETN870	Network Forensics	3(3, 0)
102	ETN871	Traffic Engineering and QoS in TCP/IP Networks	3(3, 0)
103	ETN872	Special Topics in Computer Networks	3(3, 0)
104	ETN873	Advanced Topics in Network Security	3(3, 0)
105	ETN874	Advanced Network Security	3(3, 0)
106	ETN875	Advanced Internetworking (TCP/IP) Protocols	3(3, 0)
107	ETN880	Advanced Multi-user Systems for Wireless Communications	3(3, 0)
108	ETN881	Advanced Topics in Wireless Networks	3(3, 0)
109	ETN882	Selected Topics in Wireless Network Security	3(3, 0)
110	ETN883	Selected Topics in Wireless Networks Design and Planning	3(3, 0)
111	ETN884	Advanced Mobile Applications	3(3, 0)
112	ETN885	Advanced Mobile Networking	3(3, 0)
113	ECI610	Advanced Digital Design	3(3, 0)

114	ECI611	Logic Design and Switching Theory	3(3, 0)
115	ECI612	Advanced Microprocessor Systems	3(3, 0)
116	ECI613	Advanced Operating Systems	3(3, 0)
117	ECI614	Advanced Computer Architecture	3(3, 0)
118	ECI620	ASIC and FPGA Design	3(3, 0)
119	ECI621	DSP Hardware Systems Design	3(3, 0)
120	ECI622	DSP Software Systems Design	3(3, 0)
121	ECI623	VLSI System Design	3(3, 0)
122	ECI624	Microprocessor/Microcontroller Based Systems	3(3, 0)
123	ECI630	Mobile Devices Programming	3(3, 0)
124	ECI631	Web Technologies	3(3, 0)
125	ECI632	Advanced Programming Techniques	3(3, 0)
126	ECI633	Software Development Methodologies	3(3, 0)
127	ECI634	Distributed Databases	3(3, 0)
128	ECI635	Object Oriented Databases	3(3, 0)
129	ECI636	Web Based Databases	3(3, 0)
130	ECI637	Data Structures for Computer Graphics	3(3, 0)
131	ECI640	Advanced Digital Signal Processing	3(3, 0)
132	ECI641	Digital Image Processing	3(3, 0)
133	ECI642	Digital Filters	3(3, 0)
134	ECI650	Image, Video, and Multimedia	3(3, 0)
135	ECI651	Multimedia Indexing and Retrieval	3(3, 0)
136	ECI652	Multimedia Technologies	3(3, 0)
137	ECI653	Fundamentals of Computer Graphics	3(3, 0)
138	ECI660	Linear Control Systems	3(3, 0)
139	ECI661	Digital Control Systems	3(3, 0)
140	ECI662	Optimization Control Theory	3(3, 0)
141	ECI663	Robotics	3(3, 0)
142	ECI664	Industrial Automation and Control	3(3, 0)
143	ECI665	Linear Systems Theory	3(3, 0)
144	ECI670	Neural and Fuzzy Systems	3(3, 0)
145	ECI671	Artificial Intelligence	3(3, 0)
146	ECI672	Natural Language Processing	3(3, 0)
147	ECI673	Automata Theory	3(3, 0)
148	ECI674	Pattern Recognition	3(3, 0)
149	ECI710	Computer-Aided Design of Digital Systems I	3(3, 0)
150	ECI711	Performance of Computer Systems	3(3, 0)
151	ECI712	Multithreaded Architectures	3(3, 0)
152	ECI713	Parallel Processing	3(3, 0)
153	ECI714	Diagnosis and Design of Reliable Digital Systems	3(3, 0)

154	ECI715	Real Time Computer Systems	3(3, 0)
155	ECI716	Probabilistic Methods in Computer Systems Modeling	3(3, 0)
156	ECI717	Compiler Design	3(3, 0)
157	ECI718	Analysis of Algorithms	3(3, 0)
158	ECI720	Hardware/Software Co-Design Techniques	3(3, 0)
159	ECI721	Embedded Software and RTOS	3(3, 0)
160	ECI722	Mixed-Signal VLSI Systems Design	3(3, 0)
161	ECI723	Embedded Computing Systems	3(3, 0)
162	ECI724	VLSI Architectures and Algorithms	3(3, 0)
163	ECI725	Design of Systems on a Chip (SoC)	3(3, 0)
164	ECI726	Design of Real-Time Embedded Systems	3(3, 0)
165	ECI730	Protocol Software Design and Development	3(3, 0)
166	ECI731	Data Warehousing	3(3, 0)
167	ECI732	Data Mining	3(3, 0)
168	ECI733	Requirements Engineering	3(3, 0)
169	ECI734	Software Project Management	3(3, 0)
170	ECI735	Software Quality Assurance	3(3, 0)
171	ECI736	Software Engineering Technologies	3(3, 0)
172	ECI737	Object Oriented Software Engineering	3(3, 0)
173	ECI738	Geometric Modeling	3(3, 0)
174	ECI739	Computer Animation	3(3, 0)
175	ECI740	Estimation of Signals and Systems	3(3, 0)
176	ECI741	Audio Signal Processing	3(3, 0)
177	ECI742	Adaptive Signal Processing	3(3, 0)
178	ECI743	Computer Vision	3(3, 0)
179	ECI744	Advanced Pattern Recognition	3(3, 0)
180	ECI745	3-D and Virtual Imaging	3(3, 0)
181	ECI746	Detection and Estimation Theory	3(3, 0)
182	ECI747	Advanced Filter Design	3(3, 0)
183	ECI748	Machine Learning	3(3, 0)
184	ECI750	Multimedia Data Compression	3(3, 0)
185	ECI753	Advanced Computer Graphics	3(3, 0)
186	ECI760	Non-Linear Systems & Control	3(3, 0)
187	ECI761	Intelligent Control Systems	3(3, 0)
188	ECI762	Advanced Linear Systems	3(3, 0)
189	ECI763	Multivariable Control	3(3, 0)
190	ECI764	Adaptive Control	3(3, 0)
191	ECI765	Robust Control	3(3, 0)
192	ECI770	Intelligent Systems	3(3, 0)
193	ECI810	Computer-Aided Design of Digital Systems II	3(3, 0)

194	ECI811	Special Topics in Computer Systems Architectures	3(3, 0)
195	ECI812	Advanced Topics in Digital Design	3(3, 0)
196	ECI813	Advanced Topics in Operating Systems	3(3, 0)
200	ECI814	Advanced Microprocessor/Microcontroller Systems	3(3, 0)
201	ECI815	Special Topics in Digital Design	3(3, 0)
202	ECI820	Advanced Topics in Embedded System Design	3(3, 0)
203	ECI821	Advanced Topics in VLSI Design	3(3, 0)
204	ECI822	Advanced Topics in Real-Time Embedded System Design	3(3, 0)
205	ECI833	Security Applications: Watermarking and Biometrics	3(3, 0)
206	ECI834	Data Authentication Techniques	3(3, 0)
207	ECI835	Digital Watermarking	3(3, 0)
208	ECI839	Advanced Computer Animation	3(3, 0)
209	ECI840	Special Topics in Signal Processing	3(3, 0)
210	ECI841	Advanced Topics in Image Processing	3(3, 0)
211	ECI842	Advanced Topics in Computer Vision	3(3, 0)
212	ECI847	Advanced Topics in Filter Design	3(3, 0)
213	ECI850	Advanced Topics in Multimedia Technologies	3(3, 0)
214	ECI853	Advanced Topics in Computer Graphics	3(3, 0)
215	ECI860	Advanced Topics in Control Systems	3(3, 0)
216	ECI870	Advanced Topics in AI and Neural Computing	3(3, 0)
217	ECI871	Advanced Topics in Pattern Recognition	3(3, 0)
218	ECI872	Advanced Topics in Knowledge Based Systems	3(3, 0)
219	ECI873	Advanced Topics in Decision Support Systems	3(3, 0)
220	ECI874	Advanced Topics in Machine Learning	3(3, 0)
221	EEP610	Fundamentals of Semiconductor Devices	3(3, 0)
222	EEP611	Circuit Modeling of Solid-State Devices	3(3, 0)
223	EEP612	Active Semiconductor Devices	3(3, 0)
224	EEP613	Solid State Electronic Devices	3(3, 0)
225	EEP620	Integrated Circuit Analysis and Design	3(3, 0)
226	EEP630	Theory of Optical Fibers	3(3, 0)
227	EEP631	Optical Fiber Devices and Components	3(3, 0)
228	EEP632	Semiconductor Optoelectronic Devices	3(3, 0)
229	EEP634	Laser and Modern Optics	3(3, 0)
230	EEP640	Lasers and Optical Communication	3(3, 0)
231	EEP641	Optical Communications	3(3, 0)
232	EEP642	Optical Signal Processing	3(3, 0)
233	EEP650	Introduction to MEMS	3(3, 0)
234	EEP651	Nanosystems	3(3, 0)
235	EEP652	Introduction to Nanoscience and Technology	3(3, 0)
236	EEP710	MOS VLSI Circuit Design	3(3, 0)

237	EEP711	Quantum Physical Electronics	3(3, 0)
238	EEP712	Electronic Materials	3(3, 0)
239	EEP713	Semiconductor Processing Technology	3(3, 0)
240	EEP714	Advanced Semiconductor Materials	3(3, 0)
241	EEP715	Semiconductor Power Devices	3(3, 0)
242	EEP730	Principles of Fiber and Integrated Optics	3(3, 0)
243	EEP731	Integrated Optical Circuits and Devices	3(3, 0)
244	EEP732	Optical Sensors	3(3, 0)
245	EEP740	Optical Fiber Components and Transmission Systems	3(3, 0)
246	EEP741	Optical Fiber Communication Systems	3(3, 0)
247	EEP742	High Speed Photonic Components	3(3, 0)
248	EEP810	Low Power Analog and Mixed Signal ICs	3(3, 0)
249	EEP811	Advanced Topics in Integrated Circuit Design	3(3, 0)
250	EEP812	Special Topics in Microelectronics	3(3, 0)
251	EEP813	Advanced Topics in Solid State Devices	3(3, 0)
252	EEP830	Advanced Optoelectronic and Photonic Devices	3(3, 0)
253	EEP831	Advanced Topics in Optical System and Devices	3(3, 0)
254	EEP840	Optical Networks - Transport and Switching	3(3, 0)
255	EEP841	Next Generation Optical Networks	3(3, 0)
256	EEP842	Advanced Topics in Optical Networks	3(3, 0)
257	EEP843	Advanced Topics in Optical Communications	3(3, 0)
258	EEP850	Advanced Topics in Micro Systems Fabrication	3(3, 0)
259	EPE610	Power Generation and Plant Operation	3(3, 0)
260	EPE611	Power Transmission and Distribution	3(3, 0)
261	EPE612	DC and Flexible AC Transmission	3(3, 0)
262	EPE613	Magneto-Hydrodynamic Power Generation	3(3, 0)
263	EPE620	Power System Planning	3(3, 0)
264	EPE621	Advanced Power System Protection	3(3, 0)
265	EPE622	Power Engineering Project Management	3(3, 0)
266	EPE623	High Voltage Engineering	3(3, 0)
267	EPE624	Smart Grid System Operation	3(3, 0)
268	EPE625	Advanced Power System Analysis	3(3, 0)
269	EPE626	Power System Operation and Control	3(3, 0)
270	EPE630	Power Electronics	3(3, 0)
271	EPE631	Power Electronics Design	3(3, 0)
272	EPE632	Electronics For Energy Control	3(3, 0)
273	EPE640	Design of Electrical Machines	3(3, 0)
274	EPE641	Square Wave AC Machine Design	3(3, 0)
275	EPE642	Illumination Engineering	3(3, 0)
276	EPE650	Energy Resources and Technologies	3(3, 0)

277	EPE651	Power and Energy Economic Policy	3(3, 0)
278	EPE660	Non-Conventional Energy Systems	3(3, 0)
279	EPE661	Renewable Energy	3(3, 0)
280	EPE662	Energy and Environment	3(3, 0)
281	EPE663	Renewable Energy Technologies	3(3, 0)
282	EPE664	Photovoltaic System Design	3(3, 0)
283	EPE665	Solar Power Generation	3(3, 0)
284	EPE666	Wind Power Generation	3(3, 0)
285	EPE667	Biomass and Waste Technology	3(3, 0)
286	EPE710	Hydel Power Generation	3(3, 0)
287	EPE711	Flexible AC transmission	3(3, 0)
288	EPE712	Integration of Distributed Generation	3(3, 0)
289	EPE720	Power System Dynamics	3(3, 0)
290	EPE721	High Voltage Design	3(3, 0)
291	EPE722	Power System Reliability	3(3, 0)
292	EPE723	Power System Stability and Control	3(3, 0)
293	EPE724	Power System Transients	3(3, 0)
294	EPE725	Electric Power Quality	3(3, 0)
295	EPE726	Computer Methods in Power System Analysis	3(3, 0)
296	EPE727	Advance Digital Relaying	3(3, 0)
297	EPE728	Power and Energy Management	3(3, 0)
298	EPE729	Dynamics and Control of Integrated Power System	3(3, 0)
299	EPE740	AC/DC Drives	3(3, 0)
300	EPE741	Dynamic Modeling of Electric Machines and Controls	3(3, 0)
301	EPE750	Sustainable Energy Systems	3(3, 0)
302	EPE751	Geothermal System Design	3(3, 0)
303	EPE752	Coal Pyrolysis and Gasification	3(3, 0)
304	EPE753	Marine Power Engineering	3(3, 0)
305	EPE754	Hybrid Power Systems	3(3, 0)
306	EPE755	Combined Cycle Power and Energy Systems	3(3, 0)
307	EPE760	Carbon Capture and Storage	3(3, 0)
308	EPE761	Hydrogen and Fuel Cell Technology	3(3, 0)
309	EPE762	Energy and Storage System	3(3, 0)
310	EPE820	Advanced Topics in Power Systems Engineering	3(3, 0)
311	EPE821	Optimization and Economics of Integrated Power Systems	3(3, 0)
312	EPE860	Advanced Topics in Renewable Energy	3(3, 0)
313	EEE610	Engineering Mathematics	3(3, 0)
314	EEE611	Stochastic Processes	3(3, 0)
315	EEE612	Discrete Mathematics	3(3, 0)
316	EEE613	Graph Theory	3(3, 0)

317	EEE614	Engineering Optimization	3(3, 0)
318	EEE615	Probabilistic Learning: Theory and Algorithms	3(3, 0)
319	EEE616	Optimization Theory	3(3, 0)
320	EEE621	Modeling and Simulation	3(3, 0)
321	EEE630	Professional Development	3(3, 0)
322	EEE631	Professional and Technical Communication	3(3, 0)
323	EEE632	Research Methods	3(3, 0)
324	EEE640	Innovation and Technology Development	3(3, 0)
325	EEE641	Sociological Impact of Technology	3(3, 0)
326	EEE642	Science, Politics and Ethics	3(3, 0)
327	EEE650	Project Management	3(3, 0)
328	EEE651	Engineering Project Management	3(3, 0)
329	EEE690	Industrial Project-I	3(0, 3)
330	EEE691	Independent Studies-I	3(0, 3)
331	EEE692	Directed Study-I	3(0, 3)
332	EEE710	Advanced Engineering Mathematics	3(3, 0)
333	EEE711	Advanced Stochastic Processes	3(3, 0)
334	EEE712	Optimization Techniques	3(3, 0)
335	EEE714	Advanced Numerical Analysis	3(3, 0)
336	EEE715	Numerical Linear Algebra	3(3, 0)
337	EEE720	Modern Data Analysis Methods	3(3, 0)
338	EEE721	Formal Specification and Modeling	3(3, 0)
339	EEE722	Computational Biology	3(3, 0)
340	EEE723	Biologically Inspired Computing	3(3, 0)
341	EEE730	Advanced Professional Development	3(3, 0)
342	EEE740	Advanced Electrochemistry	3(3, 0)
343	EEE741	Advanced Thermal Chemistry	3(3, 0)
344	EEE750	Power Sector Deregulation	3(3, 0)
345	EEE751	Project Feasibility Study	3(3, 0)
346	EEE790	Industrial Project-II	3(0, 3)
347	EEE791	Independent Studies-II	3(0, 3)
348	EEE792	Directed Study-II	3(0, 3)
349	EEE899	PhD Thesis	9(0, 9)

Note: Pre-requisite for each course will be specified by the instructor.

Outlines of Graduate Courses in Electrical Engineering

1. ETN610 Electromagnetic Field Theory 3(3, 0)

Basic electromagnetic theory of time-varying electromagnetic fields ; Maxwell's equations and boundary conditions; wave equation and its solutions; wave propagation, reflection and transmission; auxiliary vector potentials and construction of solutions; electromagnetic field theorems and their applications; guided wave and scattering boundary value problems, 1-D and 3-D green's functions with applications, integral equation formulation

2. ETN611 Microwave Passive Devices and Circuits 3(3, 0)

Guided waves, fundamental quantities and complements: Propagation conditions: modes, EM fields structure, transverse and semi-transverse modes, dispersion, Loss evaluation in guiding structures

BLT equation: Scattering (S) parameters: application to transmission lines and waveguides (single-mode and multimode structures), Radio frequency systems analysis: tubes and junctions.

Classical guiding structures: Waveguides, transmission lines, Microwave junction characterization

Usual transmission lines and coupled lines: Printed lines (micro-strip transmission lines, slot line, coplanar line),

Homogeneous multi conductors transmission lines, Characteristic impedance matrix, transmission line coupling,

Modal decomposition of 2-conductors structure

Filters: Reactive components based filters, Design of distributed constants circuits, Coupled lines filters, quarter-wave transformers based filters (Richard's transformation, Kuroda's identity), Surface waves filters.

Couplers: Couplers main characteristics, Ring couplers, 90° Hybrid couplers, 180° Hybrid couplers, Applications

3. ETN612 Microwave Active Devices and Circuits 3(3, 0)

Small signal microwave amplification: Transducer gain, Power gain, Available gain versus S parameters, Simultaneous match conditions, Stability factor K, Gain variations versus source and load Stability, Unconditionally stable stage, Stability circles for conditionally stable stages, Circuit Design, Matching networks examples. Practical realizations..

Low noise amplification: Noise figure and equivalent noise temperature T_e . Four noise parameters, T_e variation versus source impedance. Associated gain, Source-Pull for noise parameters measurements, Low noise transistors: MesFETs, HEMTs

Microwave oscillators: Several design models, Frequency and phase noise, Oscillator yield: "pushing", "pulling", Practical realization examples

Functional description of different devices: Mixers, Phase-shifters, detectors, step attenuators, frequency multipliers, Design of complete equipment

Linear large signal amplification (Class A): Dynamic load line, Maximum power and maximum efficiency, Effect of transistor knee, Cripps load-pull theory, Load-Pull measurements

Symmetrical design (Push-Pull): Reduced conduction angle waveform analysis (Class AB, B, C), Linearity and maximum efficiency. Push-Pull design advantages, High frequency push-pull design using two N-channel transistors and transformers

Passive networks and power amplifiers design: Line transformers and coaxial baluns theory, Power combiners, comparison of several possible designs.

Switching mode amplifiers: Ideal amplifier: class F, Class D and Class E switching amplifiers, Efficiency enhancement using auxiliary amplifier (Doherty design)

4. ETN613 Introduction to RF Front-End Design 3(3, 0)

The course aims at providing knowledge in RF front-end design in a context of today wireless communication systems. Both system- and circuit level perspective will be addressed, supported by modeling and simulation using professional tools. Introduction, Receiver and transmitter architectures, Devices and parasitic effects, System level RF front-end design, CMOS circuit design, LNAs, Mixers and Oscillators, Introduction to RF simulation tools, Integration Issues

5. ETN614 RF System Engineering and Design 3(3, 0)

Introduction: RF/Microwave bands, RF/microwave characteristics, RF/microwave system, traditional, industrial and biomedical applications, microwave hazards; Transmission line theory: Circuit representation of transmission line, transmission line equations, impedance and its transformation, Smith Chart and its applications, impedance matching techniques; RF/Microwave Transmission lines: Co-axial line, rectangular and circular wave guides, introduction to strip lines, microstrip lines; Wave guide components: Transmission line resonators, Rectangular and

circular cavity resonators, introduction of s-parameters, Hybrid junctions, Directional couplers, circulator; RF/Microwave measurements: VSWR, Frequency, Power, Noise, Q Factor, Impedance, Attenuation, Dielectric Constant, antenna Gain; Antennas: The transmitting mode: Equivalence Principles; integral source/fields relationships; far-field properties; radiated power and gain; input impedance; frequency bandwidth. Examples of applications: wire antennas, printed antennas, radiating apertures, arrays of antennas. ; The receiving mode: Antenna plane wave response; equivalent circuit; discussion of the received power; receiving cross-section; free-space propagation; multiple paths; equivalent noise temperature; RF Propagation: EM waves and propagation, Propagation mechanisms, Free Space Propagation, Reflection, Refraction, Ducting, Multi-path, Propagation over irregular terrain, Sample Link Budget Calculations, Link Structure, Fading Channels, Diversity Techniques
 RF System Design: Modulation, Bandwidth, Interference, Performance, BER vs. Noise, Bandwidth Limitations, Noise Figure, Eb/No vs. SNR, Receiver Sensitivity, Desensitization and Blocking, Dynamic Range, Intermodulation Distortion, Power Output, Spectral Efficiency and System Limitations, Sample Link Budget Calculations. Link Structure, Design Engineering, Performance Engineering, Traffic Engineering, System Noise Management, Propagation Modes, Scattering Parameter Analysis, RF Regulatory Considerations

6. ETN615 RF Filter Design 3(3, 0)

RF system Gain and Linearity, Noise Sources, Noise Factor, Resonant Circuit, Resonant Circuit, Impedance Matching, Impedance matching circuits, Circuit design and analysis, Impedance matching components, impedance matching Questor, Transmission Lines, Smith Chart, Impedance Matching with Smith Chart, Port Network Representation & S-parameters, Transistor, Other Passive Components, LNA Overview, LNA Output Matching, LNA Input Matching, LNA Power Gain, LNA Noise, LNA Noise Factor & Stability, RF Systems, Noise factor of a cascaded system, Oscillator & Voltage Controlled Oscillator, Phase noise in Oscillator, Mixer

7. ETN616 Radio Engineering 3(3, 0)

Transmission line theory: Circuit representation of transmission line, transmission line equations, impedance and its transformation, Smith Chart and its applications, impedance matching techniques; RF/Microwave Transmission lines: Co-axial line, rectangular and circular wave guides, introduction to strip lines, microstrip lines; Wave guide components: Transmission line resonators, Rectangular and circular cavity resonators, introduction of s-parameters, Hybrid junctions, Directional couplers, circulator; RF/Microwave measurements: VSWR, Frequency, Power, Noise, Q Factor, Impedance, Attenuation, Dielectric Constant, antenna Gain; Antennas: The transmitting mode: Equivalence Principles; integral source/fields relationships; far-field properties; radiated power and gain; input impedance; frequency bandwidth. Examples of applications: wire antennas, printed antennas, radiating apertures, arrays of antennas. ; The receiving mode: Antenna plane wave response; equivalent circuit; discussion of the received power; receiving cross-section; free-space propagation; multiple paths; equivalent noise temperature; RF Propagation: EM waves and propagation, Propagation mechanisms, Free Space Propagation, Reflection, Refraction, Ducting, Multi-path, Propagation over irregular terrain. Sample Link Budget Calculations, Link Structure, Fading Channels, Diversity Techniques

RF System Design: Modulation, Bandwidth, Interference, Performance, BER vs. Noise, Bandwidth Limitations, Noise Figure, Eb/No vs. SNR, Receiver Sensitivity, Desensitization and Blocking, Dynamic Range, Intermodulation Distortion, Power Output, Spectral Efficiency and System Limitations, Sample Link Budget Calculations, Link Structure, Design Engineering, Performance Engineering, Traffic Engineering, System Noise Management, Propagation Modes, Scattering Parameter Analysis, RF Regulatory Considerations

8. ETN620 Antennas Theory, Design and Applications 3(3, 0)

Antennas constitute a key component in any radio communication system. Antenna studies require specific techniques based on electromagnetics as well as signal processing. The course provides knowledge in general properties of antennas, the electromagnetic theory behind their operation, and an overview of different antenna systems. Equal weight is placed on the electromagnetic aspects important for antenna design and on system aspects. Introduction to antennas: Antenna as interface; circuit aspect and radiation aspects; trends in the evolution of antenna techniques.

The transmitting mode: Equivalence Principles; integral source/fields relationships; far-field properties; radiated power and gain; input impedance; frequency bandwidth. Examples of applications: wire antennas, printed antennas, radiating apertures, arrays of antennas.

The receiving mode: Antenna plane wave response; equivalent circuit; discussion of the received power; receiving cross-section; free-space propagation; multiple paths; equivalent noise temperature.

Antenna design and characterization techniques: Basics of numerical techniques (method of moments, FDTD, rays). Experimental techniques: direct approach (long and compact ranges) and indirect approach (near-field). Introduction to signal processing antennas, traveling wave antennas etc

9. ETN621 Radio Wave Propagation 3(3, 0)

Tropospheric propagation, Electromagnetic wave radiation, Reflection from earth's surface, Refraction, diffraction and scattering of waves in atmosphere, Radio-wave ducts and propagation, Free space attenuation. The role of the terrain in propagation .fading mechanisms – multipath, fading. Attenuation by atmospheric gases, noise, rain attenuation. Ionospheric propagation; Parameters of ionospheric propagation. Ionospheric scattering distance. Fading of radio signals in the ionosphere. Special problems of HF radio communication associated with the equatorial ionosphere. Radio noise, Prediction techniques: Calculation and measurement of field strength, power flux density, radiation and transmission loss. CCIR prediction curves. Prediction of ionospheric field strength and propagation loss, Solar and ionospheric indices for ionospheric propagation prediction

10. ETN622 RF Propagation and Planning for Wireless Communications 3(3, 0)

EM waves and propagation, Propagation mechanisms, Free Space Propagation, Reflection, Refraction, Ducting, Multi-path, Propagation over irregular terrain, Diffraction, Ground wave, Ionospheric Reflections, Tropospheric effects, Path loss calculations, Characterization of multipath phenomenon, short term fading, Statistics of fast fading, Wideband channel characterization, Diversity, Antenna basics, Antennas for wireless communications, Point-to-point and point-to-multipoint link design, Communication Standards, Statistical Propagation models in urban and rural environments, Propagation inside buildings, Applications to cellular and mobile communications, Base station and remote sites design considerations

11. ETN630 Radar Systems 3(3, 0)

Fields and waves , Radio communications and navigation , GPS , Avionics navigation systems , Celestial navigation , Surveying , Historical Perspectives , Clocks and timing , Special relativity , Inertial navigation Kalman filtering. Advanced concepts in global navigation satellite systems (GNSS) such as the American GPS (global positioning system), the European's Galileo and the Russian's GLONASS (GLObal NAVigation Satellite System). System level description, architecture and design of a wide area augmentation system (WAAS) comprising geostationary satellites overlaying GPS satellites and its vast network of monitoring and control ground stations. The equivalent EGNOS (European Geostationary Navigation Overlay Service), a precursor to Galileo and the Japanese MSAS (Multi-transport Satellite-based Augmentation System). Updates on evolving GNSS technology and GNSS backup alternatives.

12. ETN631 Satellite Communications 3(3, 0)

Introduction to satellite system, Orbital Mechanics, Linking by satellite, Available technologies (C, Ku, K-bands), Geosynchronous orbits and LEO's (Low Earth Orbits), Satellite design, Transponder design, Satellite propagation and transmission equations, Uplink characterization, Transponder characterization, Downlink characterization, Atmospheric effects, Earth station design, Uplink amplifiers, frequency converters, modulators, Downlink amplifiers, frequency converters, demodulators, Antennas, Analog modulation techniques, Digital modulation techniques, Satellite networks architectures, FDMA, TDMA, CDMA, and packet, Inter-satellite communications, Performance evaluation, Navigation by satellite, Time Difference of Arrival Techniques, GPS Systems, Limitations to Accuracy, Economic, Business, and Regulatory aspects

13. ETN632 GPS and Navigation Systems 3(3, 0)

GPS Systems, Limitations to Accuracy, Economic, Business, and Regulatory aspects, Orbital Mechanics, Linking by satellite, Available technologies (C, Ku, K-bands), Geosynchronous orbits and LEO's (Low Earth Orbits), Satellite design, Transponder design, Satellite propagation and transmission equations. Uplink characterization, Transponder characterization, Downlink characterization, Atmospheric effects, Earth station design, Uplink amplifiers, frequency converters, modulators, Downlink amplifiers, frequency converters, demodulators, Antennas, Analog modulation techniques, Digital modulation techniques, Satellite networks architectures, FDMA, TDMA, CDMA, and packet, Inter-satellite communications, Performance evaluation, Navigation by satellite, Time Difference of Arrival Techniques

14. ETN640 Communication Systems Engineering 3(3, 0)

Notification of Doctor of Philosophy in Electrical Engineering from Fall 2010

Overview of Analog Communication Systems, Introduction, Fundamental notions Block diagram of a basic digital communication system, Basics of signal analysis, Random variables and processes, Noise in communication systems and its equivalent representation; Analog signals digitization, Sampling, Quantization, Pulse Code Modulation, Differential PCM, DM, Baseband transmission, Inter-symbol interference, Eye diagrams, Nyquist criterions and pulse shaping, Common line codes and their performance analysis, Binary and M-ary signaling methods, Linear and non linear digital modulations schemes, PSK, QAM, MSK, CPM, FSK, GMSK etc., Signal space representation of digital signals, Detection theory and optimal receivers, Coherent and Non-coherent detection with additive white gaussian noise, Union bounds, Baseband and carrier transmission, Performance analysis of digital modulation schemes, Equalization, Synchronization, Introduction to multiple access techniques TDMA, CDMA, OFDMA and MC-CDMA, Communication link analysis and transmission over fading multipath channels, Source coding and channel coding techniques.

15. ETN641 Digital Communications 3(3, 0)

Principles of communication theory applied to the representation and transmission of information. analysis of deterministic and random signals, amplitude modulation, angle modulation, analog message digitization, introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding; channel coding; baseband and passband modulation techniques; receiver design; channel equalization; information theoretic techniques; block, convolutional, and trellis coding techniques; multiuser communications and spread spectrum; multi-carrier techniques and FDM; carrier and symbol synchronization

16. ETN642 Information Theory and Coding 3(3, 0)

Information measures; asymptotic equipartition property; source coding theorem; noiseless coding; cryptography, channel coding theorem; rate distortion theory; Gaussian channels; multiple user source and channel theory; binary linear block codes; Hamming Codes, Reed Muller codes; Galois fields; linear block codes over a finite field; cyclic codes; implementation circuits, BCH and Reed Solomon codes; decoding algorithms, convolutional codes and trellis based decoding, message passing decoding algorithms; trellis based soft decision decoding of block codes; coded modulation, turbo codes; low density parity check codes, Private and public-key cryptographic systems

17. ETN643 Communication Signal Processing 3(3, 0)

This course provides an overview of different enabling technologies for real-time signal processing applied to communication systems. The basic implementation technology behind areas such as, wireless communication devices, audiovisual devices, media players, PC-based multimedia, soft modems (software radio), video gaming will be covered. A hands-on approach is taken, with the aid of state-of-the-art laboratory equipment, to expose students to the real-time hardware and software aspects of modern signal processing architectures. The topics covered span conversion technologies (A/D, D/A), bus architectures and data acquisition systems, embedded DSP processors, PC-based DSP architectures and implementations, real-time operating systems (RTOS) aspects and system-on-chip (SoC) architectures. Specially design laboratory sessions are supported by introductory lectures on the particular area under study. Spatial filtering, spatiotemporal filtering, and multi-user detection for CDMA are all treated in a unified fashion. Multi-carrier Systems: OFDM (Orthogonal Frequency Division Multiplexing) systems, DMT (Discrete MultiTone) systems, cyclic prefixes, guard intervals, equalization techniques (TEQ and FEQ) Synchronization : Basic techniques for single-carrier and multi-carrier systems timing recovery, phase locked loops (PLLs), analog and digital approaches (interpolation).

Channel estimation : Multi-carrier systems and 2D channel interpolation. Channel prediction in wireless systems.

Fixed-Point Implementation and Round-Off Error Analysis : Examples from fixed and adaptative filtering.

XDSL Systems and Gigabit Ethernet : An overview of single- and multi-carrier techniques. Equalization and synchronization approaches, echo cancellation for full duplex operation over twisted pairs, multirate filtering, Interference cancellation.

Power line Communications : Channel and noise characterization, communication approaches.

DAB/DVB Broadcasting Systems : System scenario and the choice of design parameters.

18. ETN644 Wireless Communication Techniques3(3, 0)

Cellular concept, Co-channel interference, Radio propagation, Characterization of the radio channels, Doppler frequency, multi-path propagation, Deterministic and stochastic radio channel models for narrowband and broadband systems, Digital transmission through fading multi path channels, Digital carrier modulation schemes and radio transceiver architectures, Channel estimation and equalization techniques, Channel coding for wireless channels, interleaving, Diversity methods, Multiple access schemes for radio transmission, Radio link budget analysis; introduction to wireless communications systems.

19. ETN650 Communication Electronics Design 3(3, 0)

Analysis and design of electronic circuits for communication systems, with an emphasis on integrated circuits for wireless communication systems, Analysis of distortion in amplifiers with application to radio receiver design, Power amplifier design with application to wireless radio transmitters, Class A, Class B, and Class C power amplifiers, Radio-frequency mixers, oscillators, phase-locked loops, modulators, and demodulators

20. ETN651 Embedded System Design for Telecommunications 3(3, 0)

Embedded and ubiquitous system technologies including processors, DSP, memory, and software. System interfacing basics; communication strategies; sensors and actuators, mobile and wireless technology. Using pre-designed hardware and software components. Design case studies in wireless, multimedia, and/or networking domains.

21. ETN660 Digital Telephony 3(3, 0)

PSTN main functions (distribution, transmission medial and channels, switching), noise and distortions during transmission, concepts of multiplexing, Digital Telephony and PCM techniques, Synchronous Transfer Mode, Switched versus Leased Lines, Transmission networks: Pleisiochronous and Synchronous Digital Hierarchies, SDH fundamentals, Time-Division switching, Switching Network, Call processing. Control signaling and principles of Signaling Systems (SSS, N°7). Integrated Services Digital Network concept, N-ISDN target, services, modeling and user-network interfaces

22. ETN661 Telecommunication Switching Systems 3(3, 0)

Switching System Architecture: Subscriber and Line Interface, Switching Network: Matrix and Channel Graph Representations, Blocking, Non-Blocking, and Rearrangeable Networks, Control Unit, Operation and Maintenance, Switching Process: Call Detecting, Number Analysis, Call Routing, Supervision, and Metering, Signaling Equipment; Hardware and Software Structure of the Digital Switch: Time Switches and Space Switches, Path Searching, Processor Systems Architecture and Functions, Reliability and Fault Recovery, Man Machine Interface (MMI), Examples of the Present Digital Switching Systems; ATM Switching Architectures and Performance: ATM Switch Architectures, Full-, and Partial-Connection Multistage Networks, ATM Switching Structures: Minimum-Depth Blocking Networks, Non-Blocking Single and Multiple-Queuing Networks, Arbitrary-Depth Blocking Networks, Fault-Tolerant ATM Switching Architectures; New Trends in Switching: Photonic Switching, IP Switching

23. ETN662 Performance Analysis of Communication Systems 3(3, 0)

Overview of case studies. Quick review of principles of probability theory. Queuing models and physical origin of random variables used in queuing models. Various important cases of the M/M/m/N queuing system. Little's law. The M/G/1 queuing system. Simulation of queuing systems. Product form solutions of open and closed queuing networks. Convolution algorithms and Mean Value Analysis for closed queuing networks. Stochastic Petri Nets. Discrete time queuing systems.

24. ETN663 Telecommunication Network Management 3(3, 0)

In-depth study of network management issues and standards in telecommunication networks. OSI management protocols including CMIP, CMISE, SNMP, and MIB. ITU's TMN (Telecommunication Management Network) standards, TMN functional architecture and information architecture. NMF (Network Management Forum) and service management, service modeling and network management API. Issues of telecommunication network management in distributed processing environment.

25. ETN664 Optical Fiber Networks 3(3, 0)

Optical Communication Fundamentals, Optical Amplifiers and Filters, Photonic Switches, Time Division Switching, Wave Division Switching, OTDM, Introduction to Optical Networks, Single-Wavelength Optical LANs, Conventional optical networks like SONET/SDH and ATM etc, WDM Components, WDM-based LANs, Wavelength-Routed Optical Networks, Routing and Wavelength Assignment, Algorithms, WDM-based Access Networks, IP over WDM, Optical Burst Switching, Channel Coding for High-Speed Links, Network Control and Management, Optical CDMA

26. ETN665 Communication System Design 3(3, 0)

This course presents a top-down approach to communications system design. The course will cover communication theory, algorithms and implementation architectures for essential blocks in modern physical-layer communication systems (coders and decoders, filters, multi-tone modulation, synchronization sub-systems). The course is hands-on, with a project component serving as a vehicle for study of different communication techniques, architectures and implementations. This year, the project is focused on WLAN transceivers. At the end of the course, students will have gone through the complete WLAN System-On-a-Chip design process, from communication theory, through algorithm and architecture all the way to the synthesized standard-cell RTL chip representation.

27. ETN670 Communication Networks-Architectures and Protocols 3(3, 0)

Protocol design for computer communication networks, network routing, transport protocols, internetworking; Distributed systems, their motivations, applications, and organization. The network component. Network architectures. Local and long-haul networks, technologies, and topologies. Data link, network, and transport protocols. Point-to-point and broadcast networks. Routing and congestion control. Higher-level protocols. Naming. Internetworking

28. ETN671 Data Networks and Communications 3(3,0)

Layered architectures (Internet and the OSI Reference Model), Overview of networking and communication software (Sockets), Standards in networks access protocols (CSMA, etc.), Architectures and control algorithms of local-area, point-to-point, and mobile networks, Models of network interconnection, Design issues and protocols in the data link, network, and transport layers, Direct Link Networks, Encoding and Framing, Error Detection and Reliable Transmission, Ethernet and Token Ring Networks, Wireless 802.11 Networks, Packet-Switched Networks, Switching and Forwarding, Bridges and LAN Switches, Cell Switching (ATM), Internetworking, Internet Protocol (IP), Unicast and Multicast Routing, Global Internet, MPLS, End-to-End Protocols, UDP, TCP and RPC, Congestion Control and Network QoS, Resource Allocation and Queuing Disciplines, Congestion Control and Avoidance Mechanisms, Quality of Service, Representation of End-to-End Data, Presentation Formatting (ASN.1, etc.), Data Compression Techniques (JPEG, MPEG, MP3), Network Applications, DNS, HTTP, SMTP, etc., Overlay Networks and Peer-to-Peer Networking.

29. ETN672 Queuing Theory for Performance Modeling 3(3, 0)

Review of Poisson and Markov processes; Markovian and non-Markovian queuing systems; networks of queues; priority queuing; applications of the theory to computer systems and communication networks

30. ETN673 Graph Theory and Network Optimization 3(3,0)

The elements of the theory of graphs and directed graphs with motivating examples from communication networks, data structures, etc; shortest paths, depth first search, matching algorithms, parallel algorithms, minimum spanning trees, basic complexity theory, planarity, and other topics

31. ETN674 Network Management and Operational Network Security 3(3, 0)

In-depth study of network management issues and standards in telecommunication networks. OSI management protocols including CMIP, CMISE, SNMP, and MIB, ITU's TMN (Telecommunication Management Network) standards, TMN functional architecture and information architecture, NMF (Network Management Forum) and service management, service modeling and network management API, Issues of telecommunication network management in distributed processing environment

Various types of security attacks (such as intruders, viruses, and worms, DoS, DDoS) detection and reaction, tracing the source of attacks, techniques for hiding the source or destination of network traffic; secure routing protocols: protocol scrubbing, , Conventional Encryption and Public Key Cryptology, Various security services and standards (such as Kerberos, Digital Signature Standard, Pretty Good Privacy, SNMPv2 security facility), Forensic investigations

32. ETN675 Internet Architectures and Protocols 3(3,0)

Internet Architectures and Protocols. Internetworking and architectural trends, Layering and end-to-end principle, Internet routing, End-to-end transport, Fundamentals of transport protocols (connection management, error control, congestion and flow control), Internet routers, HW architectures and packet processing, Longest-match prefix algorithms and IP Lookups, Flow classifications algorithms, Active Queue Management AQM and RED, Traffic limiting/shaping algorithms.

Virtualization, Quality of Service, IntServ, Diffserv, Traffic Engineering, SS7, RSVP and Q.2931 Signaling; File Transfer Protocol, Telnet and remote login, Internet telephony (Voice over IP), RTP/RTCP, SIP and H.263, HTTP over TCP, Web caching, Content Distribution Networks, Peer to peer systems

33. ETN676 Internetworking: Architectures, Protocols and Applications 3(3, 0)

Objective: Understand the essential building blocks (algorithms, protocols) and principles in networking
Contents: Architectural trends: Layering and end-to-end principle Internet routing: OSPF, Inter-domain routing and BGP, Peering and PoPS Routing in Mobile Environments, Multicast routing, interconnection Principles End-to-end transport : Fundamentals of transport protocols (conn mgmt, error control, congestion and flow control), TCP congestion control algorithms, TCP throughput modeling and TPC-friendliness, TCP over wireless links, Recent extensions and open issues in TCP, Reliable Multicast Internet routers : HW architectures and packet processing Router hardware architectures, Longest-match prefix algorithms and IP lookups, Flow classifications algorithms, Active Queue Management (AQM) and RED, Traffic limiting/shaping algorithms. Virtualization: VLANs, Intro to ATM first, IP over ATM, LAN Emulation, MPLS Quality of Service: IntServ, Diffserv, Traffic Engineering Signaling SS7, RSVP, Q.2931

34. ETN677 Internet Applications and Services 3(3, 0)

Objective: The goal of this course is to cover a number of technologies that make up the World Wide Web. The course surveys major software technologies for use with web services, including Web protocols and architectures, Web programming, data management, enterprise services, and electronic commerce. The course is complemented by hands-on projects where students will develop and deploy their own Web services.

Contents: Overview and History of the Web : Web-servers, browsers, HTTP, HTML, URIs, Web programming : Server and client side scripting, client tracking (e.g cookies), Java or the Web. Web architectures : Proxies, caches, firewalls, server farms/clusters, content delivery networks. Enterprise Services : Application servers, Java 2 Enterprise Edition (J2EE). RPCs over HTTP (SOAP, XML-RPC). Data Management : XML for the Web, database connectivity, transaction processing. Electronic commerce Electronic Payments, web security.

35. ETN678 Design of Computer Communication Networks 3(3, 0)

Applications of stochastic modeling and optimization techniques to communication network design and analysis. Data link control; performance models; multi-access channels; routing and flow control

36. ETN679 Interconnection Networks 3(3, 0)

Theory, design and analysis of interconnection networks for multiprocessor systems, Study of direct and indirect topologies, deadlock-free routing, flow control, network interfaces, optical interconnects

37. ETN680 Wireless Networks 3(3, 0)

The cellular concept and mobile networks fundamentals, Frequency reuse, Traffic engineering, Interference, Power control, Macro diversity, Handover, Modeling of propagation channel in rural, suburban, urban and indoor environments, Channel allocation strategies, Performance measures, Coverage prediction and radio subsystem analysis, Design and planning, Quality and capacity enhancement, Introduction to radio resource optimization; 2G and 3G mobile cellular radio communication technologies, Network architectures, Protocols and procedures, Wireless LANs and Local Loop systems and standards, Wireless medium access protocols, Wireless multimedia services, Terminal and service mobility management, Security issues related to mobile internet

38. ETN681 Mobile Cellular Systems and Standards 3(3, 0)

This focus of this course is on mobile cellular technologies, starting with a brief discussion of 2G cellular networks such as GSM and cdmaOne (IS-95), the course will emphasize developments leading to 2.5G and 3G (Third Generation) Cellular Networks, namely, GPRS, UMTS and cdma2000. Major emphasis will be on Code Division Multiple Access (CDMA) that offers the best combination of good signal quality, high security, low power consumption, and excellent system reliability amongst all wireless technologies for personal communications. Although major part of the course is dedicated to Radio Access Networks (RANs), however major developments in the Core Network (CN) will also be covered. Current research in radio resource management, QoS, mobility and handoff mechanism will be an essential part of the course

39. ETN682 Mobile and Broadband Networks 3(3, 0)

Introduction: Motivation, Applications, Short History, Wireless Transmission: Communication System, Frequencies, Signals, Signal Propagation, Multiplexing, Antennas, Noise, Modulation, Spread Spectrum (FH and DSS), Cellular Architecture, Frequency Reuse, Cell Hierarchy, Handover, Wireless LANs: IEEE 802.11, WLAN QoS, WLAN Security, IP Mobility: Mobile IP, Fast Handover, Local Mobility, Roaming/Handoff, Wireless PANs: IEEE 802.15, Bluetooth, UWB, Wireless MANs: IEEE 802.16, WiMax, MBWA, MANETs: Mobile Adhoc Networks, Routing, Mesh Networks, Transport Protocols: Reliable transmission, Flow control, Quality of Service, Cellular Systems: HSCSD, EDGE, GPRS, CDMA IS-95, 3G Systems: UMTS, CDMA2000, Integration: 3G Cellular- Wireless LAN – WPAN – WMAN, Support for Mobility: File systems, WWW, WAP, i-mode, J2ME, Simulation Modeling and Analysis in order to conduct performance studies and comparative evaluation of mobile computing technologies

40. ETN683 Wireless LANs 3(3, 0)

Wireless Communication Overview, Medium Access: Contention, Hidden terminals, Capture, Physical Layer, Medium Access, Management, Wireless Network Theory: Models, Throughput, Capacity, Multihop Network Routing: Proactive vs. Reactive Routing, Dynamic Source Routing Protocol: Route Discovery & Maintenance , WLAN Applications: Hot Spots, Public Safety, Community Networks, BlueTooth and 802.15: Personal Area Networks , WLAN-like Technologies, 802.16, Metropolitan Area Networks, Sensor Networks, Simple End Devices, RFID, Tracking

41. ETN684 Mobile Applications and Services 3(3, 0)

Objective: The goals of this course are twofold. First, it aims to give a detailed description of mobile services offered by cellular wireless networks as well as those provided by emerging broadband networks. To better understand the operations of these services, an overview about the evolution of wireless systems and their architectures are discussed at the beginning of this lecture. Second, this course targets the description of new emerging technologies and tools used to design and implement multimedia applications for mobile devices (cell phones, smartphones, PDAs, etc.) taking into account the technical constraints relative to storage capacity, processing capacity, display screen, communication interfaces, and user profiles.

Contents: Introduction, GSM applications and services: SMS, GSM applications and services: WAP 1.0 and WAP 2.0. GSM applications and services: Mobile Messaging Service (MMS) • Location-Based Mobile (LBS) services • XHTML development for Mobile Phones • Mobile applications programming using J2ME Symbian OS and Symbian programming • Android OS and Android programming • iPhone OS and iPhone programming

42. ETN685 Mobile Communication Systems 3(3, 0)

To provide a fundamental understanding of mobile communication systems. The course will seek to describe the key aspects of channel characteristics/modeling, of communication techniques, and to describe the application of these techniques in wireless communication systems. The course will cover recent research developments, such as opportunistic communications, basic aspects of MIMO communications, and OFDMA. Specific topics will include basic properties of multipath fading, diversity techniques, multiple access and interference management, fundamental capacity exposition and opportunistic communications.

Contents:

Physical channel modeling, input/output channel models, time and frequency channel coherence (Doppler spread, coherence time, delay spread and coherence bandwidth), statistical channel modeling. Detection in fading channels, degrees of freedom, effects of channel uncertainty, diversity techniques (time diversity, antenna diversity, frequency diversity, space-time codes). OFDM, channel estimation: Capacity of AWGN and fading wireless channels, multi-user capacity and opportunistic communications, uplink/downlink AWGN channel, uplink/downlink fading channel, multiuser diversity, multi-node networks.

43. ETN686 Wireless Sensor Network 3(3, 0)

Introduction to wireless sensor networks, Applications, Protocols, Physical Layer, MAC Layer, Routing, Cross Layer Issues, Energy Efficiency, Implementation and Deployment, Case studies, Simulation and Experimental Studies and Analysis

44. ETN710 Electromagnetic Interference and Compatibility 3(3, 0)

Aspects of EMC with examples, Common EMC units, EMC requirements for electronic systems, Radiated emissions, Conducted emissions, ESD, Application of EMC design, Wires, PCB lands, Component leads, resistors, capacitors, inductors, ferrites, Electromechanical devices, Digital circuit devices . Mechanical switches (as
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suppression), Simple emission models for wires and PCB lands, Line impedance stabilisation network (LISN), Power supply filters. Power supplies including SMPS. Three conductor lines and crosstalk, Shielded wires, Twisted wires, Multiconductor lines and effects of incident fields, Shielding, Origin effects, prevention of ESD event, its hardware and immunity. System design for EMC, Grounding, System configuration, PCB design

45. ETN711 Numerical and Computational Techniques in Electromagnetics 3(3, 0)

Electromagnetic analytical problem formulation and solution; Method of moments (MoM) solution of integral equations for radiation and scattering, finite difference methods (finite-difference time domain (FDTD) and finite element methods (FEM))

46. ETN712 Microwave Integrated Circuits 3(3, 0)

Microwave transmission lines models; passive components models; active circuit models; transceiver architectures: analysis and circuit design of RF/Microwave switches, phase shifters, amplifiers, oscillators, detectors, mixers, filters, PLLs and directional couplers; technology of hybrid MICs; thin and thick film techniques; Mounting of active devices; low power and high power circuits; encapsulation

47. ETN713 RF and Microwave Measurement Techniques 3(3, 0)

Review of measurement and instrumentation basics. Principles and applications of various sensors used in characterization of RF materials, devices, circuits and system: acoustic, ultrasonic, magnetic, electrical, thermal, optical, radiation and smart sensors, Mechanical and thermal engineering issues for RF modules/ instruments, Instrumentation concepts and measurement techniques in: Oscilloscopes, Spectrum analyzers, Network analyzer, Lock-in-amplifiers, Waveform generators, Bit-error rate measurement, S/N measurement Telemetry, Data recording and display, Recent advances in RF and Microwave measurement Techniques

48. ETN720 Smart Antennas for Mobile Communications 3(3, 0)

Statistical signal processing concepts, Basics of mobile wireless communications, Radio-frequency signal modeling and channel characterization. Smart antennas and generalized array signal processing. Source localization problem, Joint angle and delay estimation. Smart antenna array configurations, Mobile communication systems with smart antennas

49. ETN730 Radar Signal Processing 3(3, 0)

Analysis of discrete time signal, sampling theorem, estimation of frequency content in a signal, discrete Fourier transforms random discrete signal analysis. Review of probability, auto and cross correlation, power spectral density, cross spectra. Spectral analysis of random signals, sampling autocorrelation function, window function, spectral estimates, parametric and non parametric estimates, detection of signals in noise, optimum detection algorithms, minimum probability of error, Neyman-Pearson criteria for radar application to air traffic control, radar sub optimum processor, detection of variable amplitude signals, matched filters, detection of random signal and estimation of signals in noise, Linear mean square estimation, Bayes estimator, maximum likelihood estimation of parameters of linear systems

50. ETN731 Modern Radar Systems 3(3, 0)

Radar functions, missions, performance objectives and evaluation criteria, radar frequencies, antenna types, waveforms and processing techniques, transmitter, antenna, receiver, signal processor and displays, target characteristics, radar cross section (RCS), radar range equation, physical implications, pulse integration: coherent and non-coherent, false alarms and detection probability, the search equation and its implications, optimum search time, rotating search radars, volume search using phased array radars, cued search using reflector and phased-array radars, horizon search concept and applications to reflector and phased-array radars, radar waveforms, radar measurement and tracking techniques, radar networks, multi-radar measurements, radar netting, data processing and communications, radar measurements of target characteristics, Secondary surveillance radar (SSR) and identification friend or foe (IFF), continuous-wave (CW) radar, Bi-static radar and bi-static RCS, over-the-horizon (OTH) radar, terrain and sea-surface effects: multipath, terrain clutter and MTI, Precipitation effects: attenuation and rain clutter, Atmospheric effects: attenuation, lens loss and refraction, Ionospheric effects: attenuation, polarization rotation, dispersion, and refraction, Radar countermeasures (ECM) and counter-countermeasures (ECCM), airborne and space-based radar, synthetic aperture radars (SAR).

51. ETN740 Advanced Communication Systems Engineering 3(3, 0)

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Principles of communication theory applied to the representation and transmission of information. analysis of deterministic and random signals, amplitude modulation, angle modulation, analog message digitization, introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding; channel coding; baseband and passband modulation techniques; receiver design; channel equalization; information theoretic techniques; block, convolutional, and trellis coding techniques; multiuser communications and spread spectrum; multi-carrier techniques and FDM; carrier and symbol synchronization

52. ETN741 Advanced Digital Communications 3(3, 0)

Overview of parameter estimation, Optimum detection in additive Gaussian noise. Demodulator structures and analysis; Synchronization, Levels of synchronization, ML Estimation and phase synchronization. The phase-locked loop, Phase synchronization of digitally modulated signals. Symbol time synchronization, Bit error performance with synchronization errors; Equalization, Introduction, ML demodulation, Band limited ideal channels, Non ideal channels, Linear equalization; Fading Channels, Characterization of fading channels, Channel models, Signaling over slow fading channels, Diversity techniques; Frequency Non-Selective Fading with Coherent and non- Coherent Detection (ML detection, Performance analysis), Frequency selective channels with ideal coherent detection (MMSE DFE, ZF-DFE); Multi-User Systems, CDMA, MC-CDMA; ML Multi-user joint decoder, Linear Multi-User detectors, PIC (Parallel Interference Cancellation), SIC (Successive Interference Cancellation), Performance Analysis in the large-system regime

53. ETN742 Advanced Information Theory and Coding 3(3, 0)

Advanced techniques and topics in Information Theory and Coding; Information measures; asymptotic equipartition property; source coding theorem; noiseless coding; cryptography, channel coding theorem; rate distortion theory; Gaussian channels; multiple user source and channel theory; binary linear block codes; Hamming Codes, Reed Muller codes; Galois fields; linear block codes over a finite field; cyclic codes; implementation circuits, BCH and Reed Solomon codes; decoding algorithms, convolutional codes and trellis based decoding, message passing decoding algorithms; trellis based soft decision decoding of block codes; coded modulation, turbo codes; low density parity check codes, Private and public-key cryptographic systems

54. ETN743 Adaptive Techniques for Wireless Communications 3(3, 0)

Space-time processing: Beam forming, spatial, temporal, frequency diversity, antenna gain, spatial canceling of interference. Definition of diversity order, Spatial Channel modeling, Models for SIMO, MISO, and MIMO channels, recent measurement results and spatial characteristics, Multi-input multi-output (MIMO) algorithms, MIMO coding, spatial multiplexing with MIMO, MIMO-OFDM, Transmit diversity. Multi-user MIMO algorithms; Adaptive coding and modulation: Adaptive modulation techniques for SISO mobile channels, performance over Rayleigh fading channels, Adaptive coding and modulation with MIMO, Joint design of algorithms for adaptive modulation in MIMO channels, Performance evaluation at system level, Spectral efficiency, link budget, coverage gain with MIMO. Limitations and implementation issues

55. ETN744 Advanced Wireless Communications 3(3, 0)

Advanced techniques and topics in wireless communications; Development of cellular concept, Co-channel interference, Radio propagation, Characterization of the radio channels, Doppler frequency, multi-path propagation, Deterministic and stochastic radio channel models for narrowband and broadband systems. Digital transmission through fading multi path channels, Digital carrier modulation schemes and radio transceiver architectures, Channel estimation and equalization techniques, Channel coding for wireless channels, interleaving, Diversity methods, Multiple access schemes for radio transmission, Radio link budget analysis; Modern Wireless Communication Systems: Short, medium and long range systems and applications

56. ETN745 Advanced Channel Coding Techniques 3(3, 0)

Objective: In today's communications world channel coding underlies the physical layer of all major communication systems. For example: algebraic block coding (Reed-Solomon codes) are used in the CD and DVD standards, convolutional codes are widely used in wireless systems such as GSM, IS-95 and LANs (IEEE 802.11), trellis coded modulation is used in line modems and low-density parity check codes (LDPC) will be used to combat packet losses in future internet content distribution networks. This course provides an introductory but thorough background in modern coding theory and covers both classical coding theory (block and convolutional codes).

coding for band limited channels (Coded Modulation) and the modern theory of random like codes with iterative decoding (LDPCs, Turbo Codes).

Contents: Idealized channel models: the binary symmetric channel (BSC), the binary erasure channel (BEC), the constrained-input Gaussian Channel. Block coding for BSC Linear codes, cyclic codes, decoding algorithms, weight enumerators and bounds on codes. Binary convolution codes: the algebraic structure, the dynamic structure, Viterbi decoding, weight enumerating function. Binary random-like codes: Low-Density Parity-Check codes and message-passing decoding, threshold behavior of message passing decoding: density evolution analysis, other families of random like codes: Repeat- Accumulate codes, Turbo Codes. Efficient decoding of Repeat-Accumulate and Turbo Codes: the forward-backward algorithm. Coded Modulation: trellis coded modulation, multilevel coded modulation, bit interleaved coded modulation

57. ETN746 Channel Estimation and Characterization 3(3, 0)

Characterization of the radio channels, Doppler frequency, multi-path propagation. Deterministic and stochastic radio channel models for narrowband and broadband systems. Digital transmission through fading multi path channels Channel estimation and equalization techniques. Channel coding for wireless channels.

58. ETN747 Communication Channel Modeling 3(3, 0)

To provide a fundamental understanding of mobile communication systems. The course will seek to describe the key aspects of channel characteristics/modeling, of communication techniques, and to describe the application of these techniques in wireless communication systems. The course will cover recent research developments, such as opportunistic communications, basic aspects of MIMO communications, and OFDMA. Specific topics will include basic properties of multipath fading, diversity techniques, multiple access and interference management, fundamental capacity exposition and opportunistic communications.

Contents:

Physical channel modeling, input/output channel models, time and frequency channel coherence (Doppler spread, coherence time, delay spread and coherence bandwidth), statistical channel modeling. Detection in fading channels, degrees of freedom, effects of channel uncertainty, diversity techniques (time diversity, antenna diversity, frequency diversity, space-time codes). OFDM, channel estimation; Capacity of AWGN and fading wireless channels, multi-user capacity and opportunistic communications. uplink/downlink AWGN channel, uplink/downlink fading channel, multiuser diversity, multi-node networks.

59. ETN748 Wireless Channel Modeling 3(3, 0)

This course identifies the key channel parameters, showing how they compound in a given configuration and hence how they relate to the top-level specifications. The course builds from basic models and descriptions of system behavior. Describing channel, understanding the key impairments to reliable communications and looking at system solutions to modulation, multiple access and air interface standards.

60. ETN750 Advanced Integrated Circuits for Communications 3(3, 0)

Analysis, evaluation and design of present-day integrated circuits for communications application, particularly those for which nonlinear response must be included. MOS, bipolar and BiCMOS circuits, audio and video power amplifiers, optimum performance of near-sinusoidal oscillators and frequency-translation circuits, Phase-locked loop ICs, analog multipliers and voltage-controlled oscillators; advanced components for telecommunication circuits. Use of CAD tools and systems

61. ETN760 Teletraffic Engineering 3(3, 0)

Network Traffic and Performance Metrics, Source Modeling for Speech and Video Traffic, Queuing Models for Packet & Circuit Switched Networks, Planning and Optimization of Local Exchange, Network Dimensioning, Networks of Queues, Fluid Flow Analysis, Switching and Routing, Teletraffic Issues in Internet, Teletraffic Issues in Wireless Networks, Tele traffic Issues in Optical Networks; Congestion, Traffic Shaping, Policing Priorities and QoS Issues, Simulation and Numerical Techniques

62. ETN761 Broadband Network Architectures 3(3, 0)

This course covers fundamental concepts of broadband networks. Topics include Broadband ISDN, Switching Techniques, ATM, SONET/SDH, Congestion Control, High-Speed Switching Architectures, Traffic Modeling of Broadband Services, Admission Control, Traffic Scheduling, IP/ATM Convergence, QoS Provisioning in IP Networks, and Optical Networks, applications demanding high speed communication, and gigabit test beds.

deterministic, stochastic, and simulation models, and approaches to the design and management of broadband networks.

63. ETN762 Broadband Access Networks 3(3, 0)

Study and comparison of ongoing and emerging access network technologies, including hybrid-fiber-coax, FTTP/FTTH, Gigabit Ethernet, ADSL/VDSL, and ultra wideband wireless data over fiber systems

64. ETN763 Telecommunication Software Design 3(3, 0)

Programming with sockets and remote procedure calls, real time programming concepts and strategies. Operating system design for real time systems. Encryption, file compression, and implementation of firewalls. An in-depth study of TCP/IP implementation. Introduction to discrete event simulation of networks.

65. ETN764 Modeling and Analysis of Telecommunication Networks 3(3, 0)

The course aims to provide both analytical and simulative tools that serve as a basis for addressing several performance analyses and engineering problems in computer networks and communication systems. The course will focus on how to: Apply analytical models to evaluate the relative performance of single and multiple queue systems used to model networks and protocols, design simulation experiments, develop traffic models, develop network models, and analyze results for evaluating the performance of queues, local area networks, internetworks, and protocols, Apply modeling and network design techniques to design data networks based on performance objectives and design constraints, Explain the use of network analysis tools and network monitors to determine network performance and operational problems, Demonstrate the ability to describe models, methods, and results in reports of high quality

66. ETN765 Transport and Switching Technologies 3(3, 0)

Analog and Digital Switching Technologies, Digital switching and PCM techniques, Synchronous Transfer Mode, Switched versus Leased Lines, Transmission networks: Pleisiochronous and Synchronous Digital Hierarchies, SDH fundamentals, Time-Division switching, Switching Network, Call processing, Control signaling and principles of Signaling Systems (SSS, N°7). Integrated Services Digital Network concept, N-ISDN target, services, modeling and user-network interfaces

67. ETN766 Short-Range Communication Systems 3(3, 0)

Dedicated short-range communications (DSRC) are one-way or two-way short- to medium-range wireless communication channels specifically designed for automotive use and a corresponding set of protocols and standards. EN 12253:2004 Dedicated Short-Range Communication - Physical layer using microwave at 5.8 GHz, EN 12795:2002 Dedicated Short-Range Communication (DSRC) - DSRC Data link layer: Medium Access and Logical Link Control, EN 12834:2002 Dedicated Short-Range Communication - Application layer, EN 13372:2004 Dedicated Short-Range Communication (DSRC) - DSRC profiles for RTTT applications, EN ISO 14906:2004 Electronic Fee Collection - Application interface

68. ETN767 Mobile Computing 3(3, 0)

Introduction to Mobile computing, Motivation, Applications, Short History, Wireless Transmission: Communication System, Frequencies, Signals, Signal Propagation, Multiplexing, Antennas, Noise, Modulation, Spread Spectrum (FH and DSS), Wireless Technologies: Cellular, Satellite, Wireless LANs, WLL, MANETs, Bluetooth, WiMax, UWB, Medium Access Protocol: Motivation for a specialized MAC, MACA, 802.11 MAC (DCF and PCF), Cellular Architecture: Frequency Reuse, Cell Hierarchy, Handover, Cellular Systems: 2G, GPRS, 3G Systems (UMTS, CDMA2000), Wireless LAN: IEEE 802.11, WLAN security, Wireless PAN: IEEE 802.15, Bluetooth, UWB, Wireless MAN: IEEE 802.16, WiMax, WLL, MANETs: Mobile Adhoc Networks, Routing, IP Mobility: Mobile IP, Fast Handover, Local Mobility, Transport Protocols: Reliable transmission, Flow control, Quality of Service, Support for Mobility: File systems, WWW, WAP, i-mode, J2ME, Integration: 3G Cellular- Wireless LAN – WPAN – WMAN. Overview of modern computer and networks security: attacks and countermeasures. Authentication, identification, data secrecy, data integrity, authorization, access control, computer viruses, network security.

69. ETN770 IP Routing Protocols and Internetwork Design 3(3, 0)

Interior Gateway Protocols (IGPs), Distance Vector Protocols , Link State Protocols, Open Shortest Path First (OSPF); Exterior Gateway Protocols (EGPs), Border Gateway Protocol (BGP4) and its use on the Internet; *Notification of Doctor of Philosophy in Electrical Engineering from Fall 2010*

Hierarchical Design Principles, IP Addressing and Summarization, Strategies for successful addressing Issues and Strategies of Redundancy Hot Standby, Router Protocol Network Address Translation, Applying the Principles of Network Design, OSPF Network Design Nuggets, BGP Cores and Network Scalability, Router Configuration

70. ETN771 Advanced Network Programming 3(3, 0)
 Unix Programming Environment, TCP Protocol Suite, Socket Programming, UDP and TCP Sockets, I/O Multiplexing including Non-blocking I/O, Advanced Socket Options, Name and Address Conversions, IPv4 and IPv6 Interoperability, Unix Domain Protocols, Broadcasting and Multicasting, Routing and Raw Sockets, Data Link Access, Daemon Processes, Posix Threads, Inter Process Communication, Pipes and FIFOs, Message Queues, Mutexes and Locks, Semaphores, Posix Shared Memory, Doors and RPC

71. ETN772 Networks and Computer Security 3(3, 0)
 Introduces both fundamental security principles as well as real-world applications of network and computer security. Covers a wide range of topics including authorization and access control, basic cryptography, authentication systems, e-commerce security, sensor network security, and legal and ethical issues

72. ETN773 Performance Evaluation of Computer Networks 3(3, 0)
 Review of teletraffic theory: Erlang's loss formula, equivalent random method, delay and delay-loss systems, etc.; complex simulation modeling and statistical analysis of outputs. Parameter estimation, evaluation of quality, etc. Stochastic modeling of network reliability, simulation modeling, modeling replacement strategies. An introduction to concepts of quality control, sampling for acceptance, and economic design of quality control systems are discussed, as is system reliability. Faulty tree analysis, life testing, repairable systems and the role of reliability, quality and maintainability in life-cycle costing.

73. ETN774 Cryptography and Secure Communication 3(3, 0)
 Basic concepts of cryptography, cipher systems, transposition and substitution cipher systems, block ciphers, RSA & Knapsack, methods used to attack ciphers, case studies of use of cryptographic methods in communication systems and privacy issues

74. ETN775 IP Telephony 3(3, 0)
 Provides a comprehensive overview of IP telephony architectures and protocols, with emphasis on SIP, the Session Initiation Protocol. Topics include a review of classical circuit-switched telephony, especially signaling; a review of IP networking, especially routing and addressing; peer and master-slave protocols for IP telephony (SIP, H.323, MGCP); speech coding; the transport of real-time traffic over IP (RTP and RTCP); bandwidth control; and issues in network quality of service, such as traffic modeling, dimensioning, and QoS mechanisms.

75. ETN776 Design and Analysis of Computer Communication Networks 3(3, 0)
 Applications of stochastic modeling and optimization techniques to communication network design and analysis. Data link control; performance models; multi-access channels; routing and flow control

76. ETN777 Multimedia Networking 3(3, 0)
 General concept and definition, Multimedia services and streams, Logistics Media Transport Protocols, Session Initiation Protocol (SIP), Real-Time Transport Protocol (RTP), Session Description Protocol (SDP), Codec Operation & Selection, digitization, compression primitives, types of Codecs, Media Transport, Security Issues, Firewalls, NATs, IPSec & Secure RTP, Header Compression, IP Multimedia Subsystem (IMS) architecture, Standards Bodies, and Requirements, IMS IP Core Network Nodes, Key IMS Protocols, QoS framework in networked multimedia systems, Next-Generation Network Architecture, Multiservice Switching Forum Architecture, ETSI TISPAN Architecture, Multi Protocol Label Switching (MPLS), IETF IntServ and DiffServ paradigms, Examples of Voice over IP and Video over IP, design of a media gateway capable of transporting voice calls to and from a circuit switched line to an Ethernet link

77. ETN778 Network Programming Techniques 3(3, 0)
 Unix Programming Environment, TCP Protocol Suite, Socket Programming, UDP and TCP Sockets, I/O Multiplexing including Non-blocking I/O, Advanced Socket Options, Name and Address Conversions, IPv4 and IPv6 Interoperability, Unix Domain Protocols, Broadcasting and Multicasting, Routing and Raw Sockets, Data Link

Access, Daemon Processes, Posix Threads, Inter Process Communication, Pipes and FIFOs, Message Queues, Mutexes and Locks, Semaphores, Posix Shared Memory, Doors and RPC

78. ETN779 High-Speed Switched Local Area Networks (LANs) 3(3, 0)

Introduction, Switched LANs, High Speed LANs: Giga-bit and 10Gigabit Ethernet, Discussion on various functions and process of Switched LANs, Software/Hardware implantations, Study and Analysis using Simulation/Emulation and Testbeds

79. ETN780 RF Network Planning and Design 3(3, 0)

RF Network Planning and Design provides participants with a solid understanding of RF surveys and planning, electromagnetic modeling and simulation, interference analysis and resolution, coverage analysis, propagation models, RF engineering, system specifications and performance, modulation, antenna theory, link design, traffic engineering, optimization, benchmarking, safety, RF testing and system integration and measurements. Design and production engineers and technicians interested in improving RF engineering skills through a practical approach will benefit from this course.

80. ETN781 Emerging Wireless Networks 3(3, 0)

This course would interest students who want to learn new standards of emerging and advanced wireless technologies used in future cellular, mesh, and adhoc networks as well as wireless sensor and actuators.

Broadband WiMAX networks: overview, applications and architecture; QoS management, mobility management in 802.16e, etc.

Wireless sensor networks: overview, applications and architecture; auto-organization techniques; data gathering mechanisms; reliable transport protocols; etc.

Wireless mesh networks: overview, applications and architecture; load balancing methods; channel assignment mechanisms; etc.

Wireless Vehicular Networks: introduction, applications and architectures, broadcast protocols, Delay-Tolerant Networks solutions for inter-vehicles and vehicle infrastructure communications; etc.

MAC layer issues and QoS for IEEE 802.11 standard, IEEE 802.11e, IEEE 802.11p, WIMAX, Zigbee (sensor networks) etc

81. ETN782 QoS Architectures for Multimedia Wireless Networks 3(3, 0)

Network engineering fundamentals: Traffic requirements and modeling, real-time and non-real-time traffic, traffic mix, Circuit-Switched Networks and Packet-Switched Networks properties, Evaluation and dimensioning Basis; Conceptual view on Network QoS Systems, QoS Modeling and existing QoS Architectures; ATM QoS Model and components, IntServ/RSPV QoS model and components, DiffServ QoS model and components, MPLS and its main applications (TE, QoS, VPNs); Multimedia wireless network technologies, IP-based and non-IP-based systems, bandwidth, access; IEEE 802.11 WLANs Architectures, Access protocol (MAC), Physical layers (802.11 b, a, g, .), QoS extension (802.11e); GPRS/UMTS Generic system Architecture, Services, Protocols architectures, Radio Access Networks, resource management and control, Core network, Session management, mobility management and routing; Main issues for the Next-Generation Wireless Internet: Non-IP-based and IP-based systems integration, Service quality and mobility management and end-to-end QoS support

82. ETN783 Mobile Devices Applications Development 3(3, 0)

Focus on information system applications that run on top of wireless infrastructure such as multimedia messaging, mobile inventory control, location aware services including wireless technologies (GSM, CDMA2000, UMTS, 802.11, Bluetooth), mobile information systems and applications (M-Business, location-based services, wireless CRN), wireless information system challenges and architectures (security, reliability, mobility, power conservation, gateways, proxies), mobile application protocols (SMS, EMS, MMS, WAP), thin and thick client mobile application development (WML, VXML, Java, J2ME, J2EE, .NETCF, C#), and business case studies of mobile applications

83. ETN784 Mobile Networking 3(3, 0)

Objective: This module addresses the mobility management in IP Networks (Internet or private networks). In particular the various mobility schemes based on IPv6 are detailed. Mobility management in IPv4 Networks, Comparison of the historical proposals, Basic IPv6 mechanisms, Mobile IPv6, Hierarchical Mobility (HMIP), IPv6 based Handover mechanisms, Global v.s. Local mobility management, NetLMM and ProxyMIP, Network mobility (NEMO), Mobility schemes above Network Layer

84. ETN785 Wireless Medium Access Techniques 3(3, 0)

Objective: This module addresses the MAC layer of various wireless communication standards. The interested students will learn the key elements of MAC layers applied to various applicative environments

Contents:

Introduction to wireless issues, MAC layer categories, IEEE 802.11 standard, QoS management : IEEE 802.11e, Vehicular MAC : IEEE 802.11p, WIMAX, Zigbee (sensor networks)

85. ETN786 Wireless Wide Area Networks (WWANs) 3(3, 0)

Introduction to wireless wide area networks, Applications, Protocols, Physical Layer, MAC Layer, Routing, Cross Layer Issues, Energy Efficiency, Implementation and Deployment, Case studies, Simulation and Experimental Studies and Analysis

86. ETN787 Wireless Metropolitan Area Networks (WMANs) 3(3, 0)

Introduction to wireless metropolitan area networks, Applications, Protocols, Physical Layer, MAC Layer, Routing, Cross Layer Issues, Energy Efficiency, Implementation and Deployment, Case studies, Simulation and Experimental Studies and Analysis

87. ETN788 Wireless Personal and Body Area Networks (WPANs/WBANs)

Introduction to wireless personal and body area networks, Applications, Protocols, Physical Layer, MAC Layer, Routing, Cross Layer Issues, Energy Efficiency, Implementation and Deployment, Case studies, Simulation and Experimental Studies and Analysis

88. ETN810 Advanced Topics in RF System Design 3(3, 0)

Advanced topics of current interest in RF System Design which are taken from current research topics and/or technical publications

89. ETN811 Advanced Topics in RF/Microwave Engineering 3(3, 0)

Advanced topics of current interest in RF/Microwave Engineering which are taken from current research topics and/or technical publications

90. ETN820 Advanced Topics in Antenna Design 3(3, 0)

Advanced topics of current interest in Antenna Design which are taken from current research topics and/or technical publications

91. ETN821 Advanced Topics in Radio Wave Propagation 3(3, 0)

Advanced topics of current interest in Radio Wave Propagation which are taken from current research topics and/or technical publications

92. ETN822 Advanced Topics in RF Planning and Optimization 3(3, 0)

Advanced topics of current interest in RF Planning and Optimization which are taken from current research topics and/or technical publications

93. ETN840 Special Topics in Communication Systems 3(3, 0)

Advanced topics of current interest in Communication Systems which are taken from current research topics and/or technical publications

94. ETN841 Advanced Topics in Communications Theory 3(3, 0)

Advanced topics of current interest in Communications Theory which are taken from current research topics and/or technical publications

95. ETN842 Advanced Topics in Communication Signal Processing 3(3, 0)

Advanced topics of current interest in Communication Signal Processing which are taken from current research topics and/or technical publications

96. ETN843 Advanced Topics in Wireless Communications 3(3, 0)

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Advanced topics of current interest in Wireless Communications which are taken from current research topics and/or technical publications

97. ETN844 Advanced Topics in Information Theory and Coding 3(3, 0)

Advanced topics of current interest in Information Theory which are taken from current research topics and/or technical publications

98. ETN845 Advanced Topics in Error Control Coding

Advanced topics of current interest in Error Control Coding which are taken from current research topics and/or technical publications

99. ETN846 Advanced Topics in Information Security 3(3, 0)

Advanced topics of current interest in Information Security which are taken from current research topics and/or technical publications

100. ETN850 Advanced Topics in Telecommunication Electronics 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Telecommunication Electronics. Topics are to be specified by the instructor to cover recent developments and research in Telecommunication Electronics. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

101. ETN870 Network Forensics 3(3, 0)

This course deals with the collection, preservation, and analysis of network generated digital evidence such that this evidence can be successfully presented in a court of law (both civil and criminal). The relevant federal laws will be examined as well as private sector applications. The capture/intercept of digital evidence, the analysis of audit trails, the recordation of running processes, and the reporting of such information will be examined.

102. ETN871 Traffic Engineering and QoS in TCP/IP Networks 3(3, 0)

Traffic requirements and modeling, real-time and non-real-time traffic, traffic mix, Circuit-Switched Networks and Packet-Switched Networks properties, Evaluation and dimensioning Basis, Loss Systems, Call waiting Systems; Network QoS modeling, QoS declarations, QoS control plane procedures and QoS data plane procedures. QoS strategies; ATM: QoS Model and components (VCs, Signaling, Parameters, Service Categories, traffic management, adaptations); IntServ/RSVP: QoS model and components RSVP, QoS classes (GS, CL). Traffic control functions, IPv6 capabilities; DiffServ: QoS model, Data Path components (PHBs: EF, AFs), DiffServ domains and control (SLAs, TCs, BBs); MPLS: Signaling layer, Forwarding layer, Main applications (TE, QoS, VPNs)

103. ETN872 Special Topics in Computer Networks 3(3, 0)

Advanced topics of current interest in Computer Networks which are taken from current research topics and/or technical publications

104. ETN873 Advanced Topics in Network Security 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Network Security. Topics are to be specified by the instructor to cover recent developments and research in Network Security. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

105. ETN874 Advanced Network Security 3(3, 0)

This course provides both a broad survey of intrusion patterns threatening global network operation and an investigation of countermeasures to thwart these intrusions. We analyse attacks with a systematic approach, identifying typical attack classes such as traffic subversion, masquerading, and denial of service. We present an in-depth study of intrusion detection techniques including main concepts and industrial solutions. This course does not cover cryptographic mechanisms.

Contents:

- Network vulnerabilities : Protocol attack in IP, TCP, Web, e-mail, DNS (syn flooding, tear-drop, cgi-bin, smurf, etc...), application specific exposures (mail packages, web servers, viruses)
- Intrusion Processes : Intranet attack scenarios (sniffers, spoofing), Internet attack scenarios (by-passing filters, sniffer set-up, flooding, distributed denial of service attack scripts, script kiddies)

- Intrusion Detection Basics : Principles (behaviour analysis, pattern matching, normalization), techniques (statistical methods, rule-based systems, neural networks, genetic algorithms)
- Intrusion Detection Systems : Network ID systems, sniffer detectors, ID in operating systems, log analysis
- Packet Filtering : Filtering basics, stateful inspection, relationship to mobile IP
- DoS Mitigation : Traffic tagging in routers, ingress filtering, ietf proposals
- Vulnerability Testing, Ethical Hacking

106.ETN875 Advanced Internetworking (TCP/IP) Protocols 3(3, 0)

Introduction, Advanced TCP/IP Protocols, Advanced protocols at Application, Transport, Internetwork and Network Interface Layers, Discussion on various functions and process at different layers, Software/Hardware implantations, Study and Analysis using Simulation/Emulation and Testbeds

107.ETN880 Advanced Multi-user Systems for Wireless Communications 3(3, 0)

Spread Spectrum Techniques: direct sequence and frequency hopping methods, Basics of CDMA, System Performance, Properties and generation of PN sequences, Applications of CDMA to cellular communication systems, Walsh and hash functions, Second and third generation CDMA systems/standards, Multicarrier CDMA. Synchronization and demodulation issues, Diversity techniques and Rake receiver, Cell coverage and capacity issues, Convolution and turbo codes, CDMA optimization issues, wireless LAN applications; Orthogonal Frequency Division Multiplexing; OFDMA basics, modulation and coding, radio frequency distortion analysis and crest factor reduction techniques for OFDM, timing estimation and frequency synchronization issues, medium access control design for WLAN standards, multi-carrier CDMA and OFDMA, diversity and applications of OFDM principles in digital audio and video broadcasting and WLAN applications; Frequency Non-Selective Fading channels with Coherent and non- Coherent Detection (ML detection, Performance analysis). Frequency selective channels with ideal coherent detection (MMSE DFE, ZF-DFE); Multi User Detection and Interference Cancellation in Multi-User Systems, CDMA, DS-CDMA, MC-CDMA, ML Multi-user joint decoder, Linear Multi-User detectors, PIC (Parallel Interference Cancellation), SIC (Successive Interference Cancellation), Performance Analysis in the large-system regime

108.ETN881 Advanced Topics in Wireless Networks 3(3, 0)

Advanced topics of current interest in Wireless Networks which are taken from current research topics and/or technical publications

109.ETN882 Selected Topics in Wireless Network Security 3(3, 0)

Advanced topics of current interest in Wireless Network Security which are taken from current research topics and/or technical publications

110.EEE858 Selected Topics in Wireless Networks Design and Planning 3(3, 0)

Advanced topics of current interest in Wireless Networks Design and Planning which are taken from current research topics and/or technical publications

111.ETN884 Advanced Mobile Applications 3(3, 0)

Advanced topics of current interest in Mobile Applications which are taken from current research topics and/or technical publications

112.ETN885 Advanced Mobile Networking 3(3, 0)

Advanced topics of current interest in Mobile Networking which are taken from current research topics and/or technical publications

113. ECI610 Advanced Digital Design 3(3, 0)

High-level digital design methodology using Verilog, Reusable Methodology, HDL coding for synthesis, FPGA based Digital Design, XILINX ISE 6.1i synthesis and implementation tool workshop, Datapath and Controller Design Partitioning, Design of Datapath Units, Algorithmic state machine based design, Time shared and pipeline architectures, Digital design of high speed computational unit, Single Cycle and Pipelined Processor, VLIW and SuperScalor Architecture

114. ECI611 Logic Design and Switching Theory 3(3, 0)

State minimization of incompletely specified sequential circuits; asynchronous sequential circuits; races; state assignments; combinatorial and sequential hazards in logic circuits

115. ECI612 Advanced Microprocessor Systems 3(3, 0)

Architecture of advanced microprocessors; CPU architecture, memory management and protection, interrupt and exception facilities, instruction sets, systems aspects including peripheral interfaces, communications ports, and real-time systems

116. ECI613 Advanced Operating Systems 3(3, 0)

Design and Implementation of Operating Systems. Topics include Process Synchronization and Inter process Communication; Process scheduling, Memory Management, Virtual Memory, Interrupt handling, device management, I/O, AND File Systems. Advanced issues in OS, distributed operating systems, communication, synchronization, processor allocation, and distributed file systems, multiprogramming, time-sharing, real-time processing, job and task control, synchronization of concurrent processes and processors, resource scheduling, protection, and management of hierarchical storage.

117. ECI614 Advanced Computer Architecture 3(3, 0)

Comparative studies of computer system components: the CPU, memory, and I/O; analytical modeling techniques to allow comparative evaluation of architectures; parallelism and supercomputers

118. ECI620 ASIC and FPGA Design 3(3, 0)

Introduction to ASICs, CMOS Logic, ASIC Library Design, Programmable ASICs, Programmable ASIC Logic Cells, Programmable ASIC I/O Cells, Programmable ASIC Interconnect, Programmable ASIC Design Software, Low-Level Design Entry, VHDL, Verilog HDL, Logic Synthesis, Two level combinational logic optimization, Multiple-Level combinational logic optimization, Simulation, Sequential circuit optimization, Test, System Partitioning, Floorplanning and Placement, Routing.

119. ECI621 DSP Hardware Systems Design 3(3, 0)

Design and implementation of DSP algorithms on programmable processors, multiprocessors and ASICs, Programmable DSPs, Data Path Design for DSP, Video signal processors, DSP ASIC design and VHDL, DSP Chip Synthesis, Synthesis Examples

120. ECI622 DSP Software Systems Design 3(3, 0)

Specification, evaluation, and implementation of real-time DSP applications on embedded DSP-based environments, DSP algorithms and processors, Software architecture for DSP boards and systems, DSP program framework and API, Virtual prototyping of DSP applications: Examples, DSP Application Demonstrations

121. ECI623 VLSI System Design 3(3, 0)

Integrated circuit fabrication; circuit simulation; basic device physics; simple device layout; structured chip design; timing; project chip; MOS logic; system design silicon compilers. VLSI design project; preparation of chips for fabrication; testing fabricated chips; design examples; design of specific units (e.g., buses); design techniques; testability; system integration

122. ECI624 Microprocessor/Microcontroller Based Systems 3(3, 0)

Overview of microcomputer system; Introduction to MCS-51 series Microcontrollers; 8051 pin configuration; Memory and input/output port structure; 8051/8052 timers; Serial port and interrupt handling; 8051/8052 assembly language programming; C compiler for 8051/8052 (Franklin Software); Design and interface examples:

123. ECI630 Mobile Devices Programming 3(3, 0)

Computation models and techniques for the analysis of algorithm complexity. Explores fundamental techniques such as recursion, Fourier transform ordering, dynamic programming for efficient algorithm construction. Examples include arithmetic, algebraic, graph, pattern matching, sorting, searching algorithms, NP-complete problems

124. ECI631 Web Technologies 3(3, 0)

Formal grammar; parsing methods and lexical analysis, Code generation, data-flow analysis, local and global code optimization, register allocation, data dependency analysis, unimodular transformations, vectorization, parallelization, data and computation decomposition.

125. ECI632 Advanced Programming Techniques 3(3, 0)

Advanced issues in OS, distributed operating systems, communication, synchronization, processor allocation, and distributed file systems, multiprogramming, time-sharing, real-time processing, job and task control, synchronization of concurrent processes and processors, resource scheduling, protection, and management of hierarchical storage

126. ECI633 Software Development Methodologies 3(3, 0)

This course provides operational skills required for a medium to large size software project in the area of telecommunications. Software architecture and architectural styles, Integration of code from open source libraries, packages and frameworks, software engineering methodologies and tools, design tools, UML, Version management tools, CVS or RCS, Programming tools, debuggers and profilers, Memory management tools Simulator Design

127. ECI634 Distributed Databases 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

128. ECI635 Object Oriented Databases 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

129. ECI636 Web Based Databases 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

130. ECI637 Data Structures for Computer Graphics 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

131. ECI640 Advanced Digital Signal Processing 3(3, 0)

Advanced techniques in signal processing, stochastic signal processing, parametric statistical signal models, and adaptive filtering, application to spectral estimation, speech and audio coding, adaptive equalization, noise cancellation, echo cancellation, and linear prediction; Multi-D signals, Multirate Signal Processing, Time-Frequency Representations, Filter banks, Wavelets, Linear Prediction, Autoregressive Modeling and Least Squares, Modeling Random Signals, Inverse Problems for Signal Reconstruction, Optimal Quantization

132. ECI641 Digital Image Processing 3(3, 0)

2-D sequences and systems, separable systems, projection slice, reconstruction from projections and partial Fourier information, Z transform, different equations, recursive computability, 2D DFT and FFT, 2D FIR filter design: human eye, perception, psychophysical vision properties, photometry and colorimetry, optics and image systems; image enhancement, image restoration, geometrical image modification, morphological image processing, halftoning, edge detection, image compression: scalar quantization, lossless coding, Huffman coding, arithmetic coding dictionary techniques, waveform and transform coding DCT, KLT, Hadamard, multiresolution coding pyramid, subband coding, Fractal coding, vector quantization, motion estimation and compensation, standards: JPEG, MPEG, H.xxx, pre- and post-processing, scalable image and video coding, image and video communication over noisy channels

133. ECI642 Digital Filters 3(3, 0)

Digital Systems, Characterization Description, Testing of Digital System, Inverse Systems, Stability, FIR & IIR, FIR & IIR; Recursive & Non Recursive, Analog Filter Design, Analog Chebyshev LPF Design Analog Filter Design (Contd.); Transformations, Analog frequency Transformation, Problem Solving Session on Discrete Time System, Digital Filter Structures, IIR Realizations, All Pass Realizations, Lattice Synthesis, FIR Lattice Synthesis, FIR Lattice and Digital Filter Design, IIR Filter Design, IIR Design by Bilinear Transformation, IIR Design examples, Digital to Digital Frequency Transformation, FIR Design, FIR Digital Filter Design by Windowing, FIR

design by Windowing & Frequency Sampling , Solving Problems on DSP Structures, FIR Design by Frequency Sampling.

134. ECI650 Image, Video, and Multimedia 3(3, 0)

Deterministic and stochastic image digitization, enhancement, restoration, and reconstruction, image representation, image sampling, image quantization, image transforms (e.g., DFT, DCT, Karhunen-Loeve), stochastic image models and histogram modeling, image multiresolution, edge detection, shape analysis, texture analysis, and recognition, pyramids, wavelets, 2D shape description, motion analysis, motion estimation methods, optical flow and block-based methods, and motion segmentation

135. ECI651 Multimedia Indexing and Retrieval 3(3, 0)

2-D sequences and systems, separable systems, projection slice, reconstruction from projections and partial Fourier information, Z transform, different equations, recursive computability, 2D DFT and FFT, 2D FIR filter design; human eye, perception, psychophysical vision properties, photometry and colorimetry, optics and image systems; image enhancement, image restoration, geometrical image modification, morphological image processing, halftoning, edge detection, image compression: scalar quantization, lossless coding, huffman coding, arithmetic coding dictionary techniques, waveform and transform coding DCT, KLT, Hadamard, multiresolution coding pyramid, subband coding, Fractal coding, vector quantization, motion estimation and compensation, standards: JPEG, MPEG, H.xxx, pre- and post-processing, scalable image and video coding, image and video communication over noisy channels

136. ECI652 Multimedia Technologies 3(3, 0)

Objective: The aim of this course is to provide an overview of the audio/video acquisition, storage and display systems, which are main components of multimedia systems.

Contents:

Teaching will include : Pick-up equipment : video cameras and CCD technology, Analog video signal coding . Display of video images, Magnetic recording of video signals, camcorders and VCR, Digital recording tools on microcomputers and hard disks ,Audio/video storage on CD and various CD formats, Case study

137. ECI653 Fundamentals of Computer Graphics 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

138. ECI660 Linear Control Systems 3(3, 0)

Input/Output System Models, Basic System Properties, Continuous and Discrete-Time Systems, Stability, State Space Representation, State Equations, System Equivalence, Canonical Forms, Realizations, Stability, Linearization, Controllability and Observability, Grammians, Rank Tests, Linear Feedback Control, Pole Assignment by State Feedback, LQ Control, Luenberger Observers, Separation Principle (Estimated State Feedback), Fixed-Order Compensators (System Augmentation), Introduction to Robust Control

139. ECI661 Digital Control Systems 3(3, 0)

Introduction to discrete time systems. Practical aspects of discrete time systems. Z -Transform and Inverse - Transform. Z -Transform analysis of SISO systems. Digital Signal Processing, Delta Transform, Discrete Time Fourier Transform and Applications Introduction to Discrete Time Control, Root Locus, Nyquist Theorem, State Space Analysis and design, Pole Placement Observers. Optimal Control. Sampling and Reconstruction, Stability Analysis Techniques, Digital Controller Design, Design By Root Locus

140. ECI662 Optimization Control Theory 3(3, 0)

Introduction, Formulation of optimal control problems, Parameter optimization versus path optimization, Local and global optima; general conditions on existence and uniqueness, Some basic facts from finite-dimensional optimization, The Calculus of Variations, The Euler-Lagrange equation, Path optimization subject to constraints Weak and strong extrema, The Minimum (Maximum) Principle and the Hamilton-Jacobi Theory, Pontryagin's minimum principle, Optimal control with state and control constraints, Time-optimal control, Singular solutions, Hamilton-Jacobi-Bellman (HJB) equation, and dynamical programming, Viscosity solutions to HJB, Linear Quadratic Gaussian (LQG) Problems, Finite-time and infinite-time state (or output) regulators Riccati equation and

its properties, Tracking and disturbance rejection, Kalman filter and duality, The LQG design, Nonholonomic System Optimal Control, Game Theoretic Optimal Control Design.

141. ECI663 Robotics 3(3, 0)

Introduction to the design, analysis, control, and operation of robotic mechanisms, Introduction to the use of homogeneous coordinates for kinematics, dynamics, and camera orientation; sensors and actuators, control, task planning, vision, and intelligence

142. ECI664 Industrial Automation and Control 3(3, 0)

Introduction sensors and measurement systems, Architecture of Industrial Automation Systems, Temperature, Pressure and Force measurements, Displacement and speed measurement, Flow measurement techniques, Humidity, pH etc, Signal Conditioning and Processing, Estimation of errors and Calibration, Process Control, P-- I -- D Control, Controller Tuning, Implementation of PID Controllers, Special Control Structures, Feed forward and Ratio Control, Special Control Structures Predictive Control, Inverse Response, Cascade Control, Overriding Control, Selective Control, Split Range Control, Introduction to Sequence Control, PLCs and Ladder Logic, Sequence Control, Scan Cycle, RLL Syntax, Sequence Control, Structured Design Approach, Sequence Control : Advanced RLL Programming, Sequence Control, The Hardware environment, Control of Machine tools, Introduction to CNC Machines, Control of Machine tools, Actuators, Flow Control Valves, Hydraulic Actuator Systems, Hydraulic Actuator Systems, Pumps and Motors, Proportional and Servo Valves, Pneumatic Control Systems, System Components, Pneumatic Control Systems, Controllers and Integrated Control Systems, Electric Drives, DC Motor Drives, Motor Drives, Synchronous Motor Drives, Networking of Sensors, Actuators and Controllers, Fieldbus Communication Protocol, Production Control Systems

143. ECI665 Linear Systems Theory 3(3, 0)

Linearity, Linear Systems, Linear Independence and Dependence, Linear Mapping, Projection, Reflection, Rotation, Eigen Values and Eigen Vectors, Degeneracy, Caley Hamilition Theorem, Stability, Controllability, Observability, Controllers and Observers etc

144. ECI670 Neural and Fuzzy Systems 3(3, 0)

Introduction to various structures of artificial neural networks and fuzzy logic systems, as well as special learning mechanisms such as generalized back-propagation, clustering and genetic algorithms, Applications to classification problems, binary associative memories, self-organizing maps, and nonlinear system modeling and control including on-line adaptation

145. ECI671 Artificial Intelligence 3(3, 0)

Foundations of symbolic intelligent systems, search, logic, knowledge representation, planning, learning

146. ECI672 Natural Language Processing 3(3, 0)

Examination of the issues which enable computers to employ and understand natural language; knowledge representation, memory modeling, parsing, language analysis, story understanding, and generation

147. ECI673 Automata Theory 3(3, 0)

System modeling, Network calculation, Load flow solutions and control, Three phase faults, Power stability, System protection

148. ECI674 Pattern Recognition 3(3, 0)

Computational methods for the identification and classification of objects. Feature extraction, feature-space representation, distance and similarity measures, decision rules. Supervised and unsupervised learning. Statistical pattern recognition: multivariate random variables; Bayes and minimum-risk decision theory; probability or error; feature reduction and principal components analysis; parametric and nonparametric methods; clustering; hierarchical systems. Syntactic pattern recognition: review of automata and language theory; shape descriptors; syntactic recognition systems; grammatical inference and learning. Artificial neural networks as recognition systems

149. ECI710 Computer-Aided Design of Digital Systems I 3(3, 0)

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Synthesis; partitioning; placement; routing of digital circuits; integrated circuit design methods; simulation at the switch, gate, register transfer and system levels

150. ECI711 Performance of Computer Systems 3(3, 0)

Overview of case studies. Quick review of principles of probability theory. Queuing models and physical origin of random variables used in queuing models. Various important cases of the M/M/m/N queuing system. Little's law. The M/G/1 queuing system. Simulation of queuing systems. Product form solutions of open and closed queuing networks. Convolution algorithms and Mean Value Analysis for closed queuing networks. Stochastic Petri Nets. Discrete time queuing systems.

151. ECI712 Multithreaded Architectures 3(3, 0)

Programmability of general purpose multiprocessor systems, functional programming, data-flow and multithreaded computers, existing prototypes, fault-tolerance issues

152. ECI713 Parallel Processing 3(3, 0)

Array processors, multiprocessors, pipeline processors; data flow computers; VLSI architectures; parallel numerical and non-numerical algorithms; mapping algorithms onto computer structures

153. ECI714 Diagnosis and Design of Reliable Digital Systems 3(3, 0)

Fault models; test generation; fault simulation; self-checking and self-testing circuits; design for testability; fault tolerant design techniques; case studies

154. ECI715 Real Time Computer Systems 3(3, 0)

Structure of real-time computer systems; analog signals and devices; scheduling, synchronization of multiprocessors; reliability, availability; serial/parallel computations; real-time operating systems and languages; design examples

155. ECI716 Probabilistic Methods in Computer Systems Modeling 3(3, 0)

Review of probability; random variables; stochastic processes; Markov chains; and simple queuing theory. Applications to program and algorithm analysis; computer systems performance and reliability modeling

156. ECI717 Compiler Design 3(3, 0)

Formal grammar; parsing methods and lexical analysis. Code generation, data-flow analysis, local and global code optimization, register allocation, data dependency analysis, unimodular transformations, vectorization, parallelization, data and computation decomposition.

157. ECI718 Analysis of Algorithms 3(3, 0)

Computation models and techniques for the analysis of algorithm complexity, Explores fundamental techniques such as recursion, Fourier transform ordering, dynamic programming for efficient algorithm construction. Examples include arithmetic, algebraic, graph, pattern matching, sorting, searching algorithms, NP-complete problems

158. ECI720 Hardware/Software Co-Design Techniques 3(3, 0)

FPGA and ASIC based design, Low-Power Techniques in RT Embedded System On-Chip networking, Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing

159. ECI721 Embedded Software and RTOS 3(3, 0)

Domain-specific software architectures, architectural styles, architecture description languages, software connectors, and dynamism in architectures.

160. ECI722 Mixed-Signal VLSI Systems Design 3(3, 0)

Integrated-circuit fabrication; circuit modeling and simulation; basic and advanced operational amplifiers and comparators; switched-capacitor and continuous-time filters; data converters; layout techniques. Mixed-signal VLSI design project; preparation of chips for fabrication; mixed-signal testing; current-mode techniques; nonlinear circuits; electrical and optical inputs; low-power design.

161. ECI723 Embedded Computing Systems 3(3, 0)

Notification of Doctor of Philosophy in Electrical Engineering from Fall 2010

Introduction of the methodology for the design and implementation of embedded computing systems, and its application to real-world problems. Topics include Embedded System Design Process, UML, ARM Instruct Set Architectures, CPU's Hardware Platforms, Software Design and Analysis, Embedded Operating Systems, Real-Time Scheduling, Hardware Accelerators, Distributed Embedded Systems, and Design Methodology and Quality Assurance

162. ECI724 VLSI Architectures and Algorithms 3(3, 0)

VLSI models; measures of area, volume and time; mapping algorithms; systolic arrays; area time tradeoffs; applications to signal and image processing problems.

163. ECI725 Design of Systems on a Chip (SoC) 3(3, 0)

System-on-Chip (SoC) components. System level design representations and modeling languages. System level modeling. Target architecture models, Intra-chip communication, Graph partitioning algorithms, Task time measurement, Interconnect latency modeling. Back annotation of lower timing to high level models, Synthesis of SOC components, Co-verification of SOC components: emulation, co-simulation

164. ECI726 Design of Real-Time Embedded Systems 3(3, 0)

Structure of real-time computer systems; analog signals and devices; scheduling, synchronization of multiprocessors; reliability, availability; serial/parallel computations; real-time operating systems and languages; design examples. Introduction of the methodology for the design and implementation of embedded systems, and its application to real-world problems. Topics include Embedded System Design Process, UML, ARM Instruct Set Architectures, CPU's Hardware Platforms, Software Design and Analysis, Embedded Operating Systems, Real-Time Scheduling, Hardware Accelerators, Distributed Embedded Systems, and Design Methodology and Quality Assurance

165. ECI730 Protocol Software Design and Development 3(3, 0)

Analysis of digital images and three dimensional scenes, image acquisition, representation of two and three dimensional shapes, visual cues for range estimation, image filtering and histogram based analysis for image enhancement, noise suppression, edge detection, region detection, and image segmentation, introduction to such topics as visual texture, stereo vision, structured-light ranging, and motion analysis

166. ECI731 Data Warehousing 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

167. ECI732 Data Mining 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

168. ECI733 Requirements Engineering 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

169. ECI734 Software Project Management 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

170. ECI735 Software Quality Assurance 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

171. ECI736 Software Engineering Technologies 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

172. ECI737 Object Oriented Software Engineering 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

173. ECI738 Geometric Modeling 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

174. ECI739 Computer Animation 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

175. ECI740 Estimation of Signals and Systems 3(3, 0)

Probability Theory, Random Variables, Function of Random Variable Joint Density, Mean and Variance, Random Vectors Random Processes, Random Processes and Linear systems. Some Numerical Problems, Miscellaneous Topics on Random process, Linear Signal Models, Linear Mean Sq. Error Estimation, Auto Correlation and Power Spectrum Estimation, Z-Transform Revisited Eigen Vectors/Values, The Concept of Innovation, Least Squares Estimation Optimal IIR Filters, Adaptive Filters, State Estimation, Kalman Filter-Model and Derivation, Kalman Filter-Derivation, Estimator Properties, The Time-Invariant Kalman Filter, Kalman Filter-Case Study, System identification Introductory Concepts, Linear Regression-Recursive Least Squares, Variants of LSE, Least Square Estimation, Model Order Selection Residual Tests, Practical Issues in Identification, Estimation Problems in Instrumentation and Control

176. ECI741 Audio Signal Processing 3(3, 0)

Introduction to relevant signal processing and basics of pattern recognition, Introduction to coding, synthesis, and recognition, Models of speech and music production and perception, Signal processing for speech analysis. Pitch perception and auditory spectral analysis with applications to speech and music, vocoders and music synthesizers, statistical speech recognition, including introduction to Hidden Markov Model and Neural Network approaches

177. ECI742 Adaptive Signal Processing 3(3, 0)

Introduction to Adaptive Filters, Introduction to Stochastic Processes, Stochastic Processes, Correlation Structure, FIR Wiener Filter (Real), Steepest Descent Technique, LMS Algorithm, Convergence Analysis (Mean Square), Misadjustment and Excess MSE, Sign LMS Algorithm, Block LMS Algorithm, Fast Implementation of Block LMS Algorithm, Vector Space Treatment to Random Variables, Orthogonalization and Orthogonal Projection, Orthogonal Decomposition of Signal Subspaces, RLS Lattice Recursions, RLS Lattice Algorithm, RLS Using QR Decomposition, Givens Rotation, Givens Rotation and QR Decomposition, Systolic Implementation, Singular Value Decomposition.

178. ECI743 Computer Vision 3(3, 0)

Analysis of digital images and three dimensional scenes, image acquisition, representation of two and three dimensional shapes, visual cues for range estimation, image filtering and histogram based analysis for image enhancement, noise suppression, edge detection, region detection, and image segmentation, introduction to such topics as visual texture, stereo vision, structured-light ranging, and motion analysis

179. ECI744 Advanced Pattern Recognition 3(3, 0)

Computational methods for the identification and classification of objects. Feature extraction, feature-space representation, distance and similarity measures, decision rules. Supervised and unsupervised learning. Statistical pattern recognition: multivariate random variables; Bayes and minimum-risk decision theory; probability or error; feature reduction and principal components analysis; parametric and nonparametric methods; clustering; hierarchical systems. Syntactic pattern recognition: review of automata and language theory; shape descriptors; syntactic recognition systems; grammatical inference and learning. Artificial neural networks as recognition systems

180. ECI745 3-D and Virtual Imaging 3(3, 0)

Objective: The goal of this course is to introduce the students to the main concepts and techniques used in computer graphics and image synthesis and analysis. 3D object modelling and advanced visualization methods are studied.

Specialized hardware used to speed up these computations are described with focus on specialized systems used in virtual reality applications. The application domains related to 3D and Virtual imaging are scientific and information visualization, CAD, flight simulation, games, advertising and movie special effects.

Contents: Solid and surface modeling : CSG, B-rep, free form surfaces, Voxel , Lightening models : Diffusion, specularity, refraction, reflection, radiosity

Basics 3D visualization algorithms : Transformations, shading, clipping, rendering, antialiasing

Advanced realistic 3D rendering algorithms : Cast shadowing, transparency, textures, ray tracing, radiosity

Hardware implementations of algorithms : Processors, VLSI, parallelism, specialized architectures

Virtual reality VRML, animation, input/output devices , Image Analysis Shape/structure from Motion, Stereo,

Zooming and Shading Stereoscopic Visualisation and Display Technologies

181. ECI746 Detection and Estimation Theory 3(3, 0)

Elements of hypothesis testing, Bayesian hypothesis testing, Minimax hypothesis testing, Neyman-Pearson hypothesis testing, Composite hypothesis testing, Signal detection in discrete time, Deterministic signals, Stochastic signals, Detection of known signals in noise, Detection of signals with random parameters in noise, Detection of signals in colored Gaussian noise; Elements of parameter estimation, Performance measurement criterions, Bayesian parameter estimation, Properties of estimators, Minimum-Variance unbiased estimators, Maximum A Posteriori (MAP) and Maximum-Likelihood (ML) estimators, Bounds on estimation errors, Multiple parameter estimation. Estimation of signal parameters in the face of AWGN and Colored Gaussian noise, Generalized likelihood function, Applications of detection and estimation in communications, optimum receivers.

182. ECI747 Advanced Filter Design 3(3, 0)

Advanced topics of current interest in Filter Design which are taken from current research topics and/or technical publications

183. ECI748 Machine Learning 3(3, 0)

Fundamental topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

184. ECI750 Multimedia Data Compression 3(3, 0)

Lossless compression, audio/speech coding, vector quantization, fractal compression, still images compression, JPEG and JPEG-2000, video compression techniques and MPEG standards, video transmission over wired and wireless networks

185. ECI753 Advanced Computer Graphics 3(3, 0)

Advanced topics of current interest in Computer Graphics which are taken from current research topics and/or technical publications

186. ECI760 Non-Linear Systems & Control 3(3, 0)

Introduction to Nonlinear Systems, System Trajectories, Describing Functions, Lyapunov, Stability Theory, Lasalle Theorem, Lyapunov Theory for Discrete Time Systems, Circle Criterion Passivity, Sliding Mode Control, Adaptive Control

187. ECI761 Intelligent Control Systems 3(3, 0)

The course introduces frequency domain robust control concepts for MIMO systems. Starting with SISO systems concepts like singular values, transmission zeros, stability, performance specifications and disturbance attenuation are also introduced. These concepts are mapped to MIMO systems in the remaining part of the course. After going through loop-shaping and multivariable transmission zeros, state space realizations of transfer functions is covered. These concepts and definitions are used to formulate H₂ and H_∞ controllers. These controllers are synthesized with a treatise on stability margins. Later on, m-Problem is defined and formalized

188. ECI762 Advanced Linear Systems 3(3, 0)

Linearity, Linear Systems, Linear Independence and Dependence, Linear Mapping, Projection, Reflection, Rotation, Eigen Values and Eigen Vectors, Degeneracy, Caley Hamilton Theorem, Stability, Controllability, Observability, Controllers and Observers

189.EC1763 Multivariable Control 3(3, 0)

This course uses computer-aided design methodologies for synthesis of multivariable feedback control systems. Topics covered include: performance and robustness trade-offs; model-based compensators; Q-parameterization; ill-posed optimization problems; dynamic augmentation; linear-quadratic optimization of controllers; H-infinity controller design; Mu-synthesis; model and compensator simplification; and nonlinear effects. The assignments for the course comprise of computer-aided (MATLAB®) design problems.

190.EC1764 Adaptive Control 3(3, 0)

Introduction: Basic approaches to adaptive control. Applications of adaptive control.

Identification: Error formulations linear in the parameters. Gradient and normalized gradient algorithms.

Convergence properties. Least-squares and modified least-squares algorithms. Identification of linear time-invariant systems. Adaptive observers.

Indirect adaptive control: Pole placement control. Model reference control. Predictive control. Indirect adaptation. Singularity regions.

Direct adaptive control: Linear error equations with dynamics. Gradient and pseudo-gradient algorithms. Strictly positive real transfer functions. Kalman-Yacubovitch-Popov lemma. Passivity theory. Direct model reference adaptive control. Stability proofs.

Parameter convergence: Persistency of excitation conditions. Generalized harmonic analysis and sufficient richness conditions. Averaging methods of approximation and analysis.

Robustness: Mechanisms of instability. Methods to improve robustness. Averaging analysis and tuned values.

Disturbance rejection: Adaptive internal model principle. Integral control and adaptive bias cancellation. Periodic disturbances.

191.EC1765 Robust Control 3 (3, 0)

This course is devoted to the study of topics in the area of Robust Control Theory. Robust control is defined as the control of uncertain plants - that is, systems with uncertain dynamics or unknown disturbance signals, using fixed deterministic controllers. The course deals with different transfer matrix, Nyquist and Nyquist-like techniques for robust control and several techniques and algorithms are compared. Several MATLAB based problems are assigned to facilitate better understanding of the results developed in this course. These assignments also facilitate the learning of the powerful toolboxes of MATLAB: namely, control system, robust control and synthesis tool boxes. sources of uncertainties in system modeling and particular motivation is given to the main classes of uncertainties encountered in the robust control literature as well as in general practice. The use of singular value techniques in the analysis of robust control system is then motivated and developed, first with reference to the general class of the so-called unstructured uncertainties and also with respect to a broad class of structured uncertainties. Using frequency response stability results of the Generalized Nyquist Criterion as a starting point, the effects of system uncertainties are incorporated as a perturbation about the nominal system description. The development provides a generalization of the Characteristic Locus Method for the case of uncertain systems via the E-contours and also gives a development of robustness analysis and design using the scaled singular values. The highly structured class of parametric uncertainties is introduced and the robust stability problem is solved by a new and elegant method called critical perturbation radius method, which is currently a main area of interest of the robust control group. A comparison of conservatism, computational burden, and efficiency with other techniques is also made, facilitating in-class interactions. Recent publications on these topics are discussed in the class, giving up-to-date information in the field and encouraging students to do a literature survey and even come up with their own research ideas in this field. The final section of the course gives an introduction to optimal H-infinity synthesis methods.

192.EC1770 Intelligent Systems 3(3, 0)

Objective: The objective of this course is to give student a solid background on techniques for classification and learning. The relationship with intelligence is that those techniques are often useful to build effective models in situations where no optimal solution is known, for example fraud detection in credit card usage. The resulting systems can be considered as having some kind of intelligent behaviour.

Contents:

This course will cover some basic and advanced techniques for classification and optimisation : Neural Networks, Genetic Algorithms, Simulated Annealing, Decision Trees and Bayesian Networks. Applications such as Intelligent Agents and Data mining will illustrate the practical usage.

A large part of the course will be devoted to the study of Neural Networks, which are one of the most popular methods, and as proved to be quite effective in many situations. We will study the basic perceptron, multi-layer perceptrons, the back-propagation algorithm. We will also take a look to other types of networks such as the Hopfield networks.

We will explore advanced techniques for optimisation, such as Genetic Algorithms and Simulated Annealing. We will also study the construction of classification models such as Decision Trees and Bayesian Networks. Throughout the course, we will illustrate the usage of those techniques in applications such as Intelligent Agent, Knowledge Discovery and Data Mining

193. ECI810 Computer-Aided Design of Digital Systems II 3(3, 0)

Theory and techniques for design and analysis of digital logic; specification, formal models; hardware-descriptive languages; formal verification, high level synthesis; logic synthesis

194. ECI811 Special Topics in Computer Systems Architectures 3(3, 0)

Advanced topics of current interest in Computer Architecture which are taken from current research topics and/or technical publications

195. ECI812 Advanced Topics in Digital Design 3(3, 0)

Advanced topics of current interest in Digital Design which are taken from current research topics and/or technical publications

196. ECI813 Advanced Topics in Operating Systems 3(3, 0)

Advanced topics of current interest in Operating Systems which are taken from current research topics and/or technical publications

197. ECI814 Advanced Microprocessor/Microcontroller Systems 3(3, 0)

Architecture of advanced microprocessors; CPU architecture, memory management and protection, interrupt and exception facilities, instruction sets, systems aspects including peripheral interfaces, communications ports, and real-time systems

198. ECI815 Special Topics in Digital Design 3(3, 0)

Advanced topics of current interest in Embedded System Design which are taken from current research topics and/or technical publications

199. ECI820 Advanced Topics in Embedded System Design 3(3, 0)

Advanced topics of current interest in Embedded System Design which are taken from current research topics and/or technical publications

200. ECI821 Advanced Topics in VLSI Design 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in VLSI Design. Topics are to be specified by the instructor to cover recent developments and research in VLSI Design. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

201. ECI822 Advanced Topics in Real-Time Embedded System Design 3(3, 0)

Advanced topics of current interest in Embedded System Design which are taken from current research topics and/or technical publications

202. ECI839 Advanced Computer Animation 3(3, 0)

Advanced topics of current interest in Computer Animation which are taken from current research topics and/or technical publications

203.ECI847 Advanced Topics in Filter Design 3(3, 0)

Advanced topics of current interest in Filter Design which are taken from current research topics and/or technical publications

204.ECI853 Advanced Topics in Computer Graphics 3(3, 0)

Advanced topics of current interest in Computer Graphics which are taken from current research topics and/or technical publications

205.ECI833 Security Applications: Watermarking and Biometrics 3(3, 0)

Objective: Watermarking : Watermarking allows owners or providers to hide an invisible and robust message inside a digital Multimedia document, mainly for security purposes such as owner or content authentication. There is a complex trade-off between the different parameters : capacity, visibility and robustness.

Biometrics: The security fields uses three different types of authentication: something you know, something you have, ore something you are ? a biometric. Common physical biometrics includes fingerprints, hand geometry; and retina, iris or facial characteristics. Behavioral characters include signature, voice. Ultimately, the technologies could find their strongest role as intertwined and complementary pieces of a multifactor authentication system. In the future biometrics is seen playing a key role in enhancing security, residing in smart cards and supporting personalized Web e-commerce services. Personalization through person authentication is also very appealing in the consumer product area. This course will focus on enabling technologies for Biometrics, with a particular emphasis on person verification and authentication based on or widely using image/video processing.

Contents:

Brief history of information hiding, basic principles and techniques: still images, video and 3-D video objects
Expected applications: owner authentication, content authentication, information embedding as communication with side information. Evaluation and benchmarking Malicious attacks, bit rate limitation ; counterfeiting marks ; removal attacks, etc.

Overview of different attempts to formalize watermarking

206.ECI834 Data Authentication Techniques 3(3, 0)

Fundamental and advanced topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

207.ECI635 Digital Watermarking 3(3, 0)

Fundamental and advanced topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

208.ECI839 Advanced Computer Animation 3(3, 0)

Fundamental and advanced topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

209.ECI840 Special Topics in Signal Processing 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Signal Processing. Topics are to be specified by the instructor to cover recent developments and research in Signal Processing. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic

210.ECI841 Advanced Topics in Image Processing 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Image Processing. Topics are to be specified by the instructor to cover recent developments and research in Image Processing. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

211.ECI842 Advanced Topics in Computer Vision 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in computer vision. Topics are to be specified by the instructor to cover recent developments and research in computer vision. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

212. ECI847 Advanced Topics in Filter Design 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Filter design. Topics are to be specified by the instructor to cover recent developments and research in filter design. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

213. ECI850 Advanced Topics in Multimedia Technologies 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Multimedia Technologies. Topics are to be specified by the instructor to cover recent developments and research in Multimedia Technologies. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

214. ECI853 Advanced Topics in Computer Graphics 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Computer Graphics. Topics are to be specified by the instructor to cover recent developments and research in Computer Graphics. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

215. ECI860 Advanced Topics in Control Systems 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in Control Systems. Topics are to be specified by the instructor to cover recent developments and research in Control Systems. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

216. ECI870 Advanced Topics in AI and Neural Computing 3(3, 0)

The course is designed to help the professional engineering community keep abreast of current developments in AI and Neural Computing. Topics are to be specified by the instructor to cover recent developments and research in AI and Neural Computing. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

217. ECI871 Advanced Topics in Pattern Recognition 3(3, 0)

Advanced topics of current interest in Pattern Recognition which are taken from current research topics and/or technical publications

218. ECI872 Advanced Topics in Knowledge Based Systems 3(3, 0)

Fundamental and advanced topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

219. ECI873 Advanced Topics in Decision Support Systems 3(3, 0)

Fundamental and advanced topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

220. ECI874 Advanced Topics in Machine Learning 3(3, 0)

Fundamental and advanced topics which are taken from recent books and current research topics and/or technical publications; Detailed topics to be specified by the instructor.

221. EEP610 Fundamentals of Semiconductor Devices 3(3,0)

Semiconductor material properties, equilibrium carrier distribution and non-equilibrium current-transport processes; properties of semiconductor interfaces, including MOS, Schottky-barrier and p-n junctions. The physics of operation of active devices will be examined, including bipolar junction transistors and field-effect transistors: MOSFETs, JFETs, and MESFETs. Special-purpose MOS devices including memories and imagers will be presented.

222. EEP611 Circuit Modeling of Solid-State Devices 3(3,0)

Provide physical insight into the operation of MOSFETs and BJTs, with particular emphasis on new physical effects in advanced devices. Compact (SPICE-level) transistor models will be derived from basic semiconductor physics; common simplifications made in the derivations of model equations will be detailed to provide an appreciation for the limits of model capabilities.

223. EEP612 Active Semiconductor Devices 3(3,0)

The physics of operation of active devices will be examined, including bipolar junction transistors and field-effect transistors: MOSFETs, JFETs, and MESFETs. Special-purpose MOS devices including memories and imagers will be presented.

224. EEP613 Solid State Electronic Devices 3(3,0)

Semiconductor structure, Electrons and holes, energy bands, Carrier motion, drift, diffusion recombination, P-N junctions, Bipolar junction transistors, Junction field effect transistors, Metal/semiconductor field effect transistors, Metal oxide semiconductor (MOS) devices, Integrated circuits, Optoelectronic devices (solar cells, photodiode, semiconductor lasers).

225. EEP620 Integrated Circuit Analysis and Design 3(3,0)

Development and application of advanced circuit theoretic concepts and computer based device circuit models for the design of custom analog integrated circuits; Analysis and optimized design of monolithic operational amplifiers and wide-band amplifiers; methods of achieving wide-band amplification, gain-bandwidth considerations; analysis of noise in integrated circuits and low noise design, Precision passive elements, analog switches, amplifiers and comparators, voltage reference, Serial, successive-approximation, and parallel analog-to-digital converters, Switched-capacitor and CCD filters

226. EEP630 Theory of Optical Fibers 3(3,0)

Optical fibers classification, essentials of electromagnetic theory - total internal reflections, Goos Hanchen shifts, analysis of optical wave guides, ray optics and wave optics. Characteristic equation of step-index fiber, modes and their cut-off frequencies, single-mode fibers, weakly guiding fibers, linearly polarized modes, power distribution., Graded-index fibers, WKB and other analysis, propagation constant, leaky modes, power profiles, dispersions, material, modal & waveguide, impulse response, Fiber to fiber and source to fiber couplings, splicing and jointing of fibers, fiber imperfections, nonconventional

227. EEP631 Optical Fiber Devices and Components 3(3,0)

Principle of semiconductor lasers, Modulation dynamics, Single frequency lasers, Fundamental AM and FM noise properties, linewidth, Tunable semiconductor lasers, Quantum well lasers. Electrooptic modulators and switches, Detectors, Integrated optoelectronic circuits, Optical amplifiers-semiconductor and Erbium fiber, Low coherence sources-super luminescent diodes. Tunable optical filters

228. EEP632 Semiconductor Opto-Electronic Devices 3(3,0)

Physical principles of semiconductor optoelectronic devices: optical properties of semiconductors, optical gain and absorption, wave guiding, laser oscillation in semiconductors; LEDs, physics of detectors, applications.

229. EEP634 Laser and Modern Optics 3(3,0)

Theory and applications of lasers, including ray and beam optics. Design issues include power maximization, noise properties, spectral purity and high-speed modulation. Particular emphasis on semiconductor lasers and their relevance to optical communications.

230. EEP640 Lasers and Optical Communication 3(3,0)

Theory and applications of lasers, including ray and beam optics. Design issues include power maximization, noise properties, spectral purity and high-speed modulation. Particular emphasis on semiconductor lasers and their relevance to optical communications. Physical principles of semiconductor optoelectronic devices: optical properties of semiconductors, optical gain and absorption, wave guiding, laser oscillation in semiconductors; LEDs, physics of detectors, applications. Characteristics of optical fibers, laser diodes, laser modulation, laser and fiber amplifiers, detection, demodulation, dispersion compensation, and network topologies. System topology, star network, bus networks, layered architectures, all-optical networks.

231. EEP641 Optical Communications 3(3,0)

Introduction to optical communications, Optical signaling schemes viz., IM, PL, PCM, PCM/PL, digital PPM, PTM, PFM etc., video signal, electro-optic modulators. Various receiver configurations, noise sources in optical communication, direct detection receiver, optimum gain in APD, signal-to-noise ratio (SNR) calculations, Optimization of SNR, optical preamplifier design. Optical line coding schemes, performance evaluation of various optical receivers and their comparative study, Applications of optical amplifier in the system. Optical fiber link design-power budget, time budget and maximum link length calculation, hybrid fiber co-axial/microwave links, fiber in the loop (FITL) - FTTH/FTTB, FTTC.

232. EEP642 Optical Signal Processing 3(3,0)

The course provides an introduction to the basic principles, enabling technologies, and methods for the analysis and synthesis and applications of optical filters that process signals in the time domain. These structures are finding increasing applications in the fields of broadband optical communications, sensing, radar, microwaves, and avionics. Both finite (FIR) and infinite impulse response (IIR) filters working in coherent and incoherent regimes are considered in this subject-focused text.

233. EEP650 Introduction to MEMS 3(3,0)

Study of micro-electro-mechanical devices and systems and their applications. Microfabrication techniques and other emerging fabrication processes for MEMS are studied along with their process physics. Principles of operations of various MEMS devices such as mechanical, optical, thermal, magnetic, chemical/biological sensors/actuators are studied. Topics include: bulk/surface micromachining, LIGA, microsensors and microactuators in multi-physics domain.

234. EEP651 Nanosystems 3(3,0)

Dependable and predictable systems based on subsystems and components, stochastic process their parameters and performance. Technology development and roadmapping, parallel platforms, algorithm design and mapping, reconfigurability and system management.

235. EEP652 Introduction to Nanoscience and Technology 3(3,0)

Introduction: Why nanoscience? What are the motivations? What are its goals and promises?; Basics: Electronic properties - free electrons, atoms, molecules and clusters, solids, Thermodynamics and Kinetics; Concepts of electron transport in nanoscale structures (key ideas!); Molecular electronics (experiments); Characterization techniques (chemical, structural): Optical, electron spectroscopy and diffraction; Scanning tunneling microscopy; Atomic force microscopy; Processing: direct methods & self-organization: Colloidal nanocrystals/quantum dots; Magnetic materials; Lithographic processing; Polymer processing; Surfaces; Physical vapor deposition; Sputtering; Chemical vapor deposition; Biological self-organization; Properties: Buffer layer assisted growth; Carbon nanotubes; Photonic materials; Nanomagnetism & spintronics; Nano-bio related.

236. EEP710 MOS VLSI Circuit Design 3(3,0)

Analysis and design of digital MOS VLSI circuits including area, delay and power minimization, assignments including design, layout, extraction, simulation and automatic synthesis

237. EEP711 Quantum Physical Electronics 3(3,0)

Quantum-mechanical foundation for study of nanometer-scale electronic devices. Principles of quantum physics, stationary-state eigenfunctions and eigenvalues for one-dimensional potentials, interaction with the electromagnetic field, electronic conduction in solids, applications of quantum structures

238. EEP712 Electronic Materials 3(3,0)

Principles of selection, preparation, and characterization of electronic materials with emphasis on semiconductors. Fundamentals of crystallography and crystal growth. Defect and impurity control. Thermodynamics and phase equilibria as applied to semiconductor processing. Preparation and properties of epitaxial and heteroepitaxial structures. Advanced techniques for structural, chemical and electrical characterization of electronic materials.

239. EEP713 Semiconductor Processing Technology 3(3,0)

Modern techniques for the manufacture of semiconductor devices and circuits. Techniques for both silicon and compound semiconductor processing are studied as well as an introduction to the design of experiments. Topics include: wafer growth, oxidation, diffusion, ion implantation, lithography, etch and deposition.

240. EEP714 Advanced Semiconductor Materials 3(3,0)

Elemental and compound semiconductors, differences in their bandstructures, crystal structure, electrical and optical properties, shallow and deep level dopants , bulk and epitaxial crystal growth techniques, heterostructures, quantum wells, quantum wires, quantum dots, bandgap engineering, optical and electronic components, process technology for fabricating these components, organic semiconductors.

241. EEP715 Semiconductor Power Devices

This course is focused on power semiconductor devices in general and suitable to the students of background in physics, electrical and electronic engineering. The course is divided into two parts. In first part, the basic theory and technology of power devices (Schottky & PiN-Diodes, bipolar, FETs and Thyristors, GTOs, etc) will be discussed. The topics in this regard address from dc switching to high frequency power electronics. Domestic and industrial applications are to be addressed. In terms of technology, to provide a general overview, special technology issue for device processing will also be discussed.

242. EEP730 Principles of Fiber and Integrated Optics 3(3,0)

Theory of dielectric waveguides, modes of planar waveguides, strip waveguides, optical fibers, coupled-mode formalism, directional couplers, diffractive elements, switches, wavelength-tunable filters, polarization properties of devices and fibers, step and graded-index fibers, devices for fiber measurements, fiber splices, polarization properties, and fiber systems.

243. EEP731 Integrated Optical Circuits and Devices 3(3,0)

Planar isotropic waveguide theory : guided and radiation modes, strip waveguides, anisotropic waveguides, end fiber, beam and waveguide couplers in semiconductors, electrooptic, acousto optic modulators & switches, integrated opto-electronic sources and detectors, integrated optic circuits and their applications, integrated optic logic devices.

244. EEP732 Optical Sensors 3(3,0)

Introduction: Definition of sensor, measurable quantities and overview of optical measurement principles, Review of most important characteristics of an optical signal, Review of basic components of an optical sensor, Review principles of interferometry, Review Bragg condition, Review electrooptic and elastooptic effect

Optical sensors - free space: Measurement of distance and relocation, Measurement of velocity and acceleration, Measurement of temperature

Optical sensors - optical fibers: Classification of sensors, advantages and disadvantages, Measurement of temperature, Measurement of mechanical quantities, Measurement of electrical quantities, Bragg gratings as optical fiber sensor, Distributed optical fiber sensors, Measurement of chemical quantities

245. EEP740 Optical Fiber Components and Transmission Systems 3(3,0)

To provide an understanding of optical fiber transmission techniques for the successful design and characterization of fiber-optic transmission systems and networks

Introduction to Optical Fibers: Definitions and Principles of Operation, Fabrication Methods, Attenuation and Dispersion Characteristics, Examples of Cable Designs

Optical Fibers as Communications Channels: Maxwell Equations and the Unguided Propagation of Radiation, Guided Propagation of Light in Planar Waveguides, Discretization of Propagation and the Formation of Modes, Guided Wave Propagation in Cylindrical Waveguides (Fibers), Multimode Step-index and Graded Index fibers, Modal, Waveguide, and Material Dispersion, Single-Mode Fibers and their Transmission Characteristics,

Measurement of Transmission Characteristics,. Estimation of Channel Performance from Measured Parameters

Electro Optic Components: Absorption and Emission of Light in Direct and Indirect Band-Gap Materials, Light-Emitting Diodes (LEDs), Detection of Light: PIN and Avalanche Photodiodes, Einstein's Equations for Optically Active Materials, Single-Mode and Multimode Semiconductor Lasers, Semiconductor and Doped-Fiber Optical Amplifiers, WDM Multiplexers, De-Multiplexers, and Couplers, Connecting and Splicing Fibers and Pig-tailed Optical Devices

Digital Transmission over Optical Fibers: Signal Formats and Line Codes, Intensity Modulation and Direct Detection, Point-to-Point Link Design and the Power Budget, Repeater Spacing and Trade-offs: Bandwidth, Speed, Transmitted Power and Loss, Transmitter Design, Receiver Design, Designing a Point-to-Point System
 Optical Networks: Ultra-High Capacity WDM and DWDM Networks, Degradations due to Non-linear Effects, All-Optical CDMA and TDMA Networks, Wireless Optical Networks, Future Pico-Cellular Radio-over-fiber Networks

246. EEP741 Optical Fiber Communication Systems 3(3,0)

Transmission properties of optical fibers - dispersion, attenuation, nonlinear effects (solitons), Direct detection systems: analog and digital modulation, transmitter design, receiver design, noise properties of single and multimode fiber links, dependence on source coherence, subcarrier and multichannel CATV analog transmission issues the role of optical fiber amplifiers. Coherent communication: FM noise and modulation properties of laser diodes, quantum limited detection, homodyne and heterodyne detection of various formats, laser linewidth requirements, diversity issues. Lightwave networks - WDMA, FDMA, subcarrier, TDMA, and CDMA, relative merits. Topological issues - multihop (store-and-forward) and hot-potato routing, the role of optical switching. Optical network access protocols. Optical interconnection in high speed circuit modules and computers

247. EEP742 High Speed Photonic Components 3(3,0)

Introduction: Components, General approximations, Applications

Laser diode descriptions: Longitudinal equations, Rate equation descriptions, Non-linear material properties
 Laser diode modulation and noise: Small signal modulation, large signal modulation, Linewidth and intensity noise, External feedback, Experimental characterisation

Non-linear laser dynamics: bifurcations, Chaos and its characterisation

Mode locking and short pulse generation: Mode locking theory, Q-switching and self-pulsations, Characterisation of short pulses, All-optical flip-flops: Flip-flops based on DFB lasers, Flip-Flops based on ring or disk lasers

248. EEP810 Low Power Analog and Mixed Signal ICs

Introduction to low voltage low power design techniques for analog and mixed signal CMOS ICs. CMOS OpAmps, comparators, sample and hold circuits, switched capacitor circuits, Nyquist and oversampling converters, continuous time filters, physical design issues and layout techniques.

249. EEP811 Advanced Topics in Integrated Circuit Design 3(3,0)

The course is designed to help the professional engineering community keep abreast of current developments in Integrated Circuit Design. Topics are to be specified by the instructor to cover recent developments and research in Integrated Circuit Design. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

250. EEP812 Special Topics in Microelectronics 3(3,0)

The course is designed to help the professional engineering community keep abreast of current developments in Communications Theory. Topics are to be specified by the instructor to cover recent developments and research in Communications Theory. Active participation of the students is encouraged in the form of writing and presenting papers in various research areas of the advanced topic.

251. EEP813 Advanced Topics in Solid State Devices 3(3,0)

Advanced topics of current interest in Solid State Devices which are taken from current research topics and/or technical publications

252. EEP830 Advanced Optoelectronic and Photonic Devices 3(3,0)

Basics of Optoelectronics: Absorption & emission of radiation, Generation & recombination events, Absorption length & spectral coverage; Optoelectronic Emitters: LEDs, LASERs, Flat panel displays; Optoelectronic Detectors: Photoconductors, MSMs, Photodiodes, APDs, Schottky diodes; Basics of High Frequency, High Power Devices: Basic transport issues, Nonstationary transport - velocity overshoot, Heterojunctions, Wide band gap semiconductors, Heterojunction Bipolar Transistors: HBT operation, Phototransistors, High frequency operation; Field Effect Transistors: MESFET operation, GaAs MESFETs, High Frequency MESFETs, HEMTs; Passive Photonic Devices: Interaction of light with matter; Gaussian beams and resonator optics; periodic structures, optical thin films and gratings; photonic band gap materials; waveguides and couplers, birefringent materials and polarization devices. Ultrafast Photonics: Short optical pulse generation; nonlinear optical effects; ultrafast optical

phenomena; short optical pulse characterization techniques; pulse compression and temporal shaping; temporal and spatial solitons; and, as time permits, photonic devices and applications.

253. EEP831 Advanced Topics in Optical System and Devices 3(3,0)

Advanced topics of current interest in Optical System and Devices which are taken from current research topics and/or technical publications

254. EEP840 Optical Networks - Transport and Switching 3(3,0)

Synchronous Optical Network (SONET)/Synchronous Digital Hierarchy (SDH) and Gigabit Ethernet; SONET/SDH Overview, Ring Configurations: UPSR, BLSR; Multiplexing Hierarchy/Formats: OC/STS-n, Overhead vs. payload, Virtual Tributary (VT) Multiplexing, Concatenated formats: OC-3c, 12c, 48c, 192c, Data over SONET, Generic Framing Procedure, ATM over SONET, Packet over SONET (POS), Gigabit/10 Gigabit Ethernet Alternative, 1 Gigabit Ethernet, 1000-base SX/LX, 10 Gigabit Ethernet Interfaces (10G-base LR/ER/SR/etc.), WAN Phys, LAN Phys, WWDM/4-Lane LAN, Reliability Options, Spanning Tree/Rapid Spanning Tree, Resilient Packet Ring, Pros and Cons: SONET vs. Gigabit Ethernet, H. Wave-division Multiplexing, Basic Components/Configurations, Bit Rate and Range Tradeoffs, Metro vs. Long Haul (CWDM/DWDM), Current and Potential Capacities, Areas for Expansion, Wavelengths, Channel spacing (50 GHz, 25 GHz, 12.5 GHz), Bandwidth efficiency, Basics of Optical Switching, Major Categories: Edge, Grooming, Core Switches, Channel Equalization Options, Optical Add/Drop Multiplexers (OADM), All-optical Cross Connect, Transparent vs. opaque, Optical switching technologies: 2-D/3-D MEMS, Bubbles, Liquid Crystals, Solid State (Lithium Niobate), Specialized: tunable lasers, wavelength converters, Optical-Electronic-Optical (O-E-O) Cross Connect, Advantages/disadvantages, STS/STM-n switching, Clos vs. Torus architectures, Control Plane Options, Proprietary Optical UNI, GMPLS, Optical Packet Switching, Packet Switching vs. Channel/Lambda Switching, Basic Approaches: Optical Transparent Packet Network (OTPN), Optical Burst Switching (OBS), Multiprotocol Label Switching/Multiprotocol Lambda Switching (MPLS), Optical Network Configurations, Fundamental Applications: Access, Metropolitan, Long Distance, International, Access Arena, Next-generation digital loop carrier, Private and semi-private networks, Wavelength services/Virtual Dark Fiber, Passive Optical Networks (PONs): APONs, EPONs, BPONs, Metropolitan area Ethernet, Multiservice Provisioning Platforms: LuxN, ONI, Appian; Wide Area: O-E-O elimination/pass through, Mesh networks/virtual SONET rings, Wide area wavelength services, Developing Areas in Optical Networking, Transparent Optical Networks, Tunable Lasers, Wavelength Conversion, Code Division Multiple Access, Semiconductor Optical Amplifiers/Raman Amplifiers, Generalized MPLS, Optical Processing and Storage

255. EEP841 Next Generation Optical Networks 3(3,0)

Introduction of Current and Upcoming Global Optical Networking standards. Course will introduce the currently deployed Optical Networking Standards, primarily SONET and proceed with the evolution of the next generation Optical Networks as envisioned by the various standards body. Standards work on Automatic Switched Optical Networks being worked at ITU will be covered along with Generalized Multi-Protocol Label Switching being worked at IETF. The course will also cover the evolution of Ethernet from Local Area Networking to Wide Area Networking, specifically G.Etna standard that is being developed at ITU and T1.X1 committee and 802.xxx developed by IEEE.

256. EEP842 Advanced Topics in Optical Networks 3(3,0)

Advanced topics of current interest in Optical Networks which are taken from current research topics and/or technical publications

257. EEP843 Advanced Topics in Optical Communications 3(3,0)

Advanced topics of current interest in Optical Communications which are taken from current research topics and/or technical publications

258. EEP850 Advanced Topics in Micro Systems Fabrication 3(3,0)

Advanced topics of current interest in Micro Systems Fabrication which are taken from current research topics and/or technical publications

259. EPE610 Power Generation and Plant Operation 3(3,0)

Energy Sources, Energy Cycles, Combustion, Steam Power Stations, Boilers, Condensers, Water conditioning, Cooling Water Supply, Water Power and Hydraulic Structure, Steam and Hydraulic , Turbines, Gas Turbine, Nuclear Power Reactors, Steam Generators, Nuclear Safety

260. EPE611 Power Transmission and Distribution 3(3,0)

Power system architecture and composition, sinusoidal steady-state basic quantities, per units, Load curves, symmetrical components , Parameters and modeling of the overhead and underground lines, Steady-state operation of power transmission and distribution networks, Power transformers, power stations and substations, Voltage control, Symmetrical and unsymmetrical faults, Network protection

261. EPE612 DC and Flexible AC Transmission 3(3,0)

Introduction, Converters and Inverters, High Voltage DC Transmission, Traditional FACTS Controllers, VSI Based FACTS Controllers, Application of FACTS Controllers, Controller Interactions

262. EPE613 Magneto-Hydraulic Power Generation 3(3,0)

Magnetohydrodynamics (MHD) (magnetofluidynamics or hydromagnetics) is the academic discipline which studies the dynamics of electrically conducting fluids. Examples of such fluids include plasmas, liquid metals, and salt water. The word magnetohydrodynamics (MHD) is derived from magneto- meaning magnetic field, and hydro- meaning liquid, and -dynamics meaning movement. CONTENTS:

Ideal and resistive MHD ,Ideal MHD equations, Applicability of ideal MHD to plasmas, Importance of resistivity, Importance of kinetic effects, Structures in MHD systems ,MHD waves ,Extensions to magnetohydrodynamics ,Resistive MHD, Extended MHD, Two-Fluid MHD, Hall MHD, Collisionless MHD, Applications , Geophysics, Astrophysics Engineering

263. EPE620 Power System Planning 3(3,0)

Load forecasting, Generation planning, Power Transmission planning, Power Distribution planning, Environmental constrain

264. EPE621 Advanced Power System Protection 3(3,0)

Introduction, Review of Background Material, Relaying Instrumentation , Protection Fundamentals , Protective Relaying Applications , Stability, Reclosing, and Load Shedding , Fundamentals of Automation

265. EPE622 Power Engineering Project Management 3(3,0)

Introduction to Project Management, The Strategic Relevance of Project Management & Project Stakeholders, Project Organization, Project Selection & Portfolio Management, Project Methodology and Process Groups , The Project Initiation / Definition Phase, The Project Planning Phase I – The Work Breakdown Structure,; The Project Planning Phase II – Human Resource Issues, Costing, Risk Analysis, Project Partnering & Outsourcing; The Project Planning Phase III : Scheduling Project Activities, Project Implementation , Project Leadership, Communication & Teams, Project Monitoring, Evaluation and Control, Project Closure / Termination

266. EPE623 High Voltage Engineering 3(3,0)

Conduction and breakdown, Generation of High voltage, current and measurements, Over voltage and insulation coordination, High voltage testing of insulation and electrical apparatus

267. EPE624 Smart Grid System Operation 3(3,0)

Introduction to smart grid and emerging technologies. Operating principles and models of smart grid components, including distributed energy sources and distribution feeder components. Communication infrastructures for smart grid operation. Advanced metering infrastructure and advanced control methods. Demand response and demand management. Distribution feeder analysis. Impact of smart grid component integration on distribution network operation. Smart grid reliability evaluation.

268. EPE625 Advanced Power System Analysis 3(3,0)

System modeling, Network calculation, Load flow solutions and control, Three phase faults, Power stability, System protection.

269. EPE626 Power System Operation and Control 3(3,0)

The Power System Control Problem, Analysis Techniques, Review of Energy Management Systems, Real Time Modeling, Energy/Economy Functions and Control, Energy/Economy Functions and Control, System Security Monitoring and Control

270. EPE630 Power Electronics 3(3,0)

Principles of Power Electronic Converters, DC/DC converter, Invertors, Controlled rectifiers and their application, High Power Applications

271. EPE631 Power Electronics Design 3(3,0)

Converters, Inverters, Regulators, Trouble shooting, active filters, PF correction, Harmonics control, Project design on UPS

272. EPE632 Electronics For Energy Control 3(3,0)

Single and three phase converter, HVDC, FACTS, UPS, Wind Turbines, Fuel Cells, Electric Vehicles, variable speed drives, semiconductor devices used in power electronic systems, static converters for single and three phase rectification and inversion design, standby and portable ac supplies, and AC transmission networks, dynamic voltage restorer applications, DC/DC converters for Fuel Cell and Electric Vehicle applications.

273. EPE640 Design of Electrical Machines 3(3,0)

Introduction, Electrical Machine Construction, Alternator Basics, Design of Induction Machine, Synchronous machines /Alternators, DC machine; Design of Transformer which includes Power Transformer, Distribution transformers, Instrumentation transformer

274. EPE641 Square Wave AC Machine Design 3(3,0)

Switching mode power supplies and square wave invertors, pulse width modulation techniques, speed control of AC Drives

275. EPE642 Illumination Engineering 3(3,0)

Radiation, color, eye & vision, different entities of illuminating systems, Light sources, daylight, incandescent, electric discharge, fluorescent, arc lamps and lasers, Luminaries, wiring, switching & control circuits. Laws of illumination, illumination from point, line and surface sources, Photometry and spectrophotometry, photocells, Environment and glare, General illumination design, Interior lighting, industrial, residential, office departmental stores, indoor stadium, theater and hospitals Exterior lighting, flood, street, aviation and transport lighting, lighting for displays and signaling, neon signs, LED-LCD displays beacons and lighting for surveillance, Utility services for large building/office complex & layout of different meters and protection units, Different type of loads and their individual protections, Selection of cable/wire sizes, potential sources of fire hazards and precautions, Emergency supply – stand by & UPS, A specific design problem on this aspect.

276. EPE650 Energy Resources and Technologies 3(3,0)

Thermodynamics, Fundamentals Of Energy, Energy Resources & Technology, Quality of Energy, Complete Cycle Analysis of Fossil Fuels, Energy in Transportation, Other Fossil Fuels, Energy Economics : Input-Output Analysis, Thermal Power Plants, Hydroelectric Power, Nuclear Power Generation, Nuclear Fusion Reactors, Environmental Effects of Conventional Power, Solar Thermal Energy Conversion, Solar Concentrating Collectors, Photovoltaic Power Generation, Wind Energy, Wind Electrical Conversion , Tidal Energy, Ocean Thermal Energy Conversion, Solar Pond and Wave Power, Geothermal Energy, Solar Distillation and Biomass Energy, Energy Storage, Magneto hydrodynamic Power Generation, Hydrogen Economy.

277. EPE651 Power and Energy Economic Policy 3(3,0)

This course examines economic theory, empirical perspectives, and political economy of energy supply and demand. It discusses aspects of local, national, and global markets for oil, natural gas, coal, electricity, nuclear power, and renewable energy; and examines public policies affecting energy markets including taxation, price regulation and deregulation, energy efficiency, and control of emissions.

278. EPE660 Non-Conventional Energy Systems 3(3,0)

Fossil fuel based systems, Impact of fossil fuel based systems, Non conventional energy -Hybrid energy systems, Distributed energy systems and dispersed generation (DG), Traditional energy systems, Solar thermal systems, Solar Photovoltaic systems, Microhydel: Components of a microhydel power plant, Types and characteristics of turbines, Selection and modification, Load balancing, Wind: Wind patterns and wind data, Site selection, Types of wind mills, Characteristics of wind generators, Load matching, Biomass: Combustion and fermentation, Anaerobic digester, Wood gasifier, Pyrolysis, Applications, Bio gas, Wood stoves, Bio diesel, Combustion engine, Wave Energy Systems: Shoreline, Near shore, Off shore systems, Costing: Life cycle costing (LCC), Solar thermal system LCC, Solar PV system LCC, Microhydel LCC, Wind system LCC, Biomass system LCC, Hybrid Systems, Need for Hybrid Systems, Range and type of Hybrid systems, Case studies of Diesel-PV, Wind-PV, Microhydel-PV, Biomass-Diesel systems, electric and hybrid electric vehicles

279. EPE661 Renewable Energy 3(3,0)

Photo Voltaic Cells, Solar Heating system of power Generation, Tidal energy, Wind Energy, Hydrogen based power Generation, Designing of Wind turbines, Designing of Hydrogen based advanced Boilers, Energy Sources Development, Selection of plant and energy source, Specific Economic energy problems

280. EPE662 Energy and Environment 3(3,0)

The course gives an understanding of Environmental Law, Rule of Law, Implementation and Enforcement of Environmental Law, Environmental Regulation of the Energy Sector, International Conventions and their Application to the Energy Sector, Environmental Impact Assessment, Energy and Environment Issues in Competitive Energy Markets

281. EPE663 Renewable Energy Technologies 3(3,0)

Introduction to renewable energy sources. The environmental benefits of PV solar panels, wind turbine generators, Bio-gas, Tidal energy and Geothermal energy. Practical information about the amount of electricity that can realistically be generated and the costs involved. Planning for solar or wind installation. Exploring health and safety issues, calculating wind and solar electricity systems to meet requirements. Full circuit design including cable sizing, connections, fuses, and battery bank. Using power inverters to convert DC battery electricity from the battery bank into a domestic 240VAC supply and system maintenance.

282. EPE664 Photovoltaic System Design 3(3,0)

This course will provide the student technician with the fundamental knowledge of photovoltaic system design and installation. This course will be suitable for a supervised, entry level position with a dealer/installer or other photovoltaic industry company. Student technicians will learn the practical design criteria, installation guidelines, safety issues, maintenance, and legal considerations of photovoltaic systems. 85 hours/17 weeks. Instructor mentored.

283. EPE665 Solar Power Generation 3(3,0)

The objectives of this course on Solar power generation, is to familiarize the students with basic Solar power generation technology and associated components. The students will be expected to analyze a complex Solar power system and define the basic control methodology with associated constraints. They will be expected to include into their analysis advantages and limitations, generation cost, and management.

284. EPE666 Wind Power Generation 3(3,0)

It is an Intensive practical course in which students will learn Wind energy and power generation basics, Wind turbine components and standards, Machinery review and comparisons, Collector system and SCADA, Reactive compensation, Interconnection with the grid.

285. EPE667 Biomass and Waste Technology 3(3,0)

This course will introduce fundamental principles and practical applications of biomass-to renewable energy processes, including anaerobic digestion of agricultural and industrial wastes for biogas and hydrogen production, bioethanol production from starch and lignocellulosic materials, biodiesel production from plant oils, and thermoconversion of biomass and waste materials for renewable energy production.

286. EPE710 Hydel Generation 3(3,0)

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Extent and prevalence of hydropower, Geographic distribution and availability of hydropower resources,, Trajectory of hydropower technologies, Economics of hydropower; sustainability attributes, Hydel power Generation in Pakistan

287. EPE711 Flexible AC transmission 3(3,0)

FACTS-Devices and Applications, Modeling of Multi-Functional Single Converter FACTS in Power Flow Analysis, Modeling of Multi-Converter FACTS in Power Flow Analysis, Modeling of FACTS-Devices in Optimal Power Flow Analysis, Modeling of FACTS in Three-Phase Power Flow and Three-Phase OPF Analysis, Steady State Power System Voltage Stability Analysis and Control with FACTS, Steady State Voltage Stability of Unbalanced Three-Phase Power Systems, Congestion Management and Loss Optimization with FACTS. Non-Intrusive System Control of FACTS. Autonomous Systems for Emergency and Stability Control of FACTS, Wide Area Control of FACTS., Modeling of Power Systems for Small Signal Stability Analysis with FACTS, Linear Control Design and Simulation of Power System Stability with FACTS

288. EPE712 Integration of Distributed Generation 3(3,0)

Introduction , Drivers of DG growth , Challenges to increased penetration of DG , Path forward---active distribution network management , Ancillary services from DG, Technical impacts of DG on transmission system operation , Development of the transmission network , Opportunities for increasing DG penetration

289. EPE720 Power System Dynamics 3(3,0)

Basic Concepts and Definitions, Dynamic Modeling of Power System Components, Transient Stability Analysis, Small Signal Stability Analysis, Sub Synchronous , Oscillations, Voltage Stability, Introduction to Bifurcation Analysis

290. EPE721 High Voltage Design 3(3,0)

Corona and corona losses, Electromagnetic noise, Dielectric strength, Lightning, Impulse testing and safety practices, Elements of high-power circuit interruption, Circuit and physical phenomena, Circuit breakers

291. EPE722 Power System Reliability 3(3,0)

Probability and Reliability: Review of probability concepts, probability distributions, applications of binomial distribution to engineering problems, probability distribution in reliability evaluation, reliability indices, network modeling and evaluation of simple and complex networks, system reliability evaluation using probability distributions, frequency and load duration techniques, key indices of power system reliability and their calculations. Generation System Reliability Evaluation : Concept of loss of load probability (LOLP), Energy demand, E(DNS), Evaluation of these indices for isolated systems, generation system, reliability analysis using the frequency and duration techniques. Transmission System Reliability Evaluation: Evaluation of LOLP and E(DNS), indices for an isolated transmission system, interconnected system reliability, bulk power system reliability. Distribution System Reliability Evaluation : Reliability analysis of radial systems with perfect and imperfect switching

292. EPE723 Power System Stability and Control 3(3,0)

Introduction to Power System Stability, Review of Equipment Characteristics and Modeling, Control of Active Power and Frequency, Control of Reactive Power and Voltage, Transient (angle) Stability, Small-Signal (angle) Stability, Examples of major system disturbances due to small-signal instability Subsynchronous Oscillations: Steam turbine generator torsional characteristics, Torsional interaction with power system controls: PSS, HVDC converter controls, Subsynchronous resonance, Impact of network-switching disturbances, Voltage Stability, Frequency Stability, Wind Turbine Generators, Major Power Grid Blackouts in 2003, Comprehensive Approach to Power System Security, Risk-based Dynamic security Assessment.

293. EPE724 Power System Transients 3(3,0)

Introduction to Project Management, The Strategic Relevance of Project Management & Project Stakeholders, Project Organization, Project Selection & Portfolio Management, Project Methodology and Process Groups , The Project Initiation / Definition Phase, The Project Planning Phase I – The Work Breakdown Structure.; The Project Planning Phase II – Human Resource Issues, Costing, Risk Analysis, Project Partnering & Outsourcing; The Project Planning Phase III : Scheduling Project Activities, Project Implementation , Project Leadership, Communication & Teams, Project Monitoring, Evaluation and Control, Project Closure / Termination

294. EPE725 Electric Power Quality 3(3,0)

Introduction, Terms and definitions, Voltage sags and interruptions, Transient over voltages. Fundamentals of harmonics, Applied harmonics, Long-duration voltage variations, Power quality benchmarking, Distributed generation and power quality, Wiring and grounding, Power quality monitoring

295. EPE726 Computer Methods in Power System Analysis 3(3,0)

Graph of a power system, incidence matrices, primitive network, formation of network matrices by singular and non singular transformation, Representation of power system for computerized analysis, mathematical model of synchronous generator for steady state and transient analysis, transformer with tap changer, transmission line, phase shifter and loads, Algorithm for formation of bus impedance matrix, modification for changes in the network. Incidence and network matrices for three phase network, transformation matrices, algorithm for formation of bus impedance matrix for three phase networks, Symmetrical component, Thevenin's theorem and short circuit analysis of multi node power systems using bus impedance matrix, Short circuit calculations for balanced and unbalanced faults, types of buses, load flow equations, power flow solution through GS and NR methods, decoupled and fast decoupled methods, sparsity, including synchronous machines, system network and loads, solution of swing equation by Euler's, Euler's modified and RK methods, unit commitment, transmission loss, load scheduling considering transmission losses, unit commitment by dynamic programming method, start up consideration, reliability analysis, hydrothermal scheduling.

296. EPE727 Advance Digital Relaying 3(3,0)

Analog to digital conversion, Data acquisition, Processing techniques, Hardware implementation, relaying schemes for utility networks.

297. EPE728 Power and Energy Management 3(3,0)

The course intends to create awareness of various aspects of energy management to the users. The course discusses various techniques of energy management applicable to buildings as well as industrial applications such as Building Management Systems and other sensor networks for Energy management.

298. EPE729 Dynamics and Control of Integrated Power System 3(3,0)

Modeling and simulation of synchronous and induction machines, transmission line dynamics and simulation, computer representation of excitation systems, governor and prime mover dynamics, interconnected system dynamics, theory of neglecting electromagnetic transients, time scale separation, transient stability studies, simulation methods, dynamic stability analysis, heroic measures for transient stability enhancement.

299. EPE740 AC/DC Drives 3(3,0)

Principle of vector control and current control methods, Introduction to the dSPACE system ,Design of a vector controller for a PMSM motor, Parameter tuning for the controller, Indirect and direct Flux oriented control of Induction Machines, Design of current controllers, Generalized flux-vector oriented control, Introduction to parameter sensitivity analysis, Introduction to sensorless control of Induction Machines, Implementation of the vector controller in dSPACE

300. EPE741 Dynamic Modeling of Electric Machines and Controls 3(3,0)

Introduction; overview of simulation software, notion of systems, steady-state and dynamic modeling, state models. review of numerical methods, introduction to Simulink, modeling of basic RLC circuits Stationary Magnetically, Coupled Circuits, Transformer, equations, magnetic saturation, implementation, reference frame theory, motivation, transformation of resistive, inductive, and capacitive circuits, frequently used reference frames, induction machine, equations, magnetic saturation, implementation, Synchronous machine, transient stability, equal-area criterion, critical clearing time, three-phase inverters, voltage equations and waveforms, VSI , PWM, space-vector modulation, CSI, hysteresis current modulation, delta modulation; inverter-fed RL load, Induction motor drives, volt/hertz strategy; field oriented control, maximum torque/amp, and maximum efficiency control schemes, Brushless DC motor drives.

301. EPE750 Sustainable Energy Systems 3(3,0)

Solar energy system, Wind energy system,Nuclear energy System, Geothermal system, Tidal System, Hydel Generation. Storage requirements

302. EPE751 Geothermal System Design 3(3,0)

This course covers geothermal heating and cooling systems. Topics covered include how heat pumps work; ground as a heat source and sink; system types; case studies; design issues; expected performance and the economics of a system.

303. EPE752 Coal Pyrolysis and Gasification 3(3,0)

This Course aims to investigate the effects of dewatering on the primary pyrolysis behavior and gasification reactivity of coal.

304. EPE753 Marine Power Engineering 3(3,0)

This Course is aimed at engineers who wish to specialize in design, analysis and operation of power systems on offshore structures and the specialized ships and systems that operate in the offshore field.

305. EPE754 Hybrid Power Systems 3(3,0)

There are many different concepts for hybrid systems. Small electrical systems up to a few kW generally use batteries and often do not have motor driven gensets. Wind and solar photovoltaics are often combined because they complement each other on a daily and seasonal basis. The wind often blows when the sun is not shining and vice versa. Energy resources for hybrid systems. Components studies. Design and measurements of a standalone PV system. Study of system solutions. Measurements and calculations on a standalone PV/Wind hybrid system. Computer programs for system design, performance and economic evaluation. Hybrid Systems components: Solar panel, Wind turbine, Solar panel & wind turbine mounting frame and kit, Controller Battery bank .Power inverter ,Panel box

306. EPE755 Combined Cycle Power and Energy Systems 3(3,0)

Basic concepts ,Conversion of chemical energy to heat, Heat into mechanical energy, Fuel processing, Feed water heating and de-aeration , Boiler operation , Steam turbine generator , Steam condensing, Combined heat and power

307. EPE760 Carbon Capture and Storage 3(3,0)

This course covers the science, technology, and policy aspects of carbon capture and storage (CCS). It provides in-depth understanding of CCS's role in the climate change mitigation portfolio, the technical approaches to CO₂ capture, the science behind geological storage, site selection and risk evaluation, and the role of policy in establishing a market and business opportunities for CCS. It will be beneficial to future scientists, engineers, managers and policy makers seeking careers in the area of energy, and especially those involved in strategies for climate change mitigation.

308. EPE761 Hydrogen and Fuel Cell Technology 3(3,0)

This course is designed to give an understanding of fuel cell devices that use hydrogen as a fuel to produce electrons, protons, heat and water. Student will learn the method of simple combustion relating fuel cells and hydrogen.

309. EPE762 Energy and Storage System 3(3,0)

In this course the students will learn various techniques for energy storage, demand Supply Management, Demand Charge, Off-Peak and On-Peak factors. Energy storage systems include electrochemical, chemical and thermal. The principles of electrochemical energy systems and fundamentals of electrochemistry, secondary batteries and fuel cells are considered. The latest advanced batteries for stationary and mobile applications, including the vanadium redox flow battery, sodium sulphur, zinc-bromine, sodium metal chloride and nickel-hydride are discussed. Laboratory work includes battery design, testing and performance calculations.

310. EPE820 Advanced Topics in Power Systems Engineering 3(3,0)

Modeling and simulation of Power generation, Power transmission, Power Distribution, Power system components, Load sharing, Stability and control

311. EPE821 Optimization and Economics of Integrated Power Systems (3-0-3)

Relevant factors in power system operation, theory of optimization under equality and inequality constraints, computational methods, and application to generation scheduling in integrated power systems.

312. EPE860 Advanced Topics in Renewable Energy 3(3,0)

Modern wind turbine technology, Wind characteristics and resources, Aerodynamics of wind turbines, Electrical system of wind turbines, Wind turbine topology, materials and design technology, Wind turbine control strategies, Wind turbine system design and integration, Wind energy system economics, environmental aspects and impacts, Wind turbine and wind farms in power systems, Offshore wind power technology, Wind turbines in hybrid power generation systems

313. EEE610 Engineering Mathematics 3(3,0)

Perturbation theory for algebraic equations, Regular perturbation theory (power series) and its shortcomings, Asymptotics and uniformity; stretched time, Boundary-layer problems, Introduction to PDEs and boundary-value problems, The heat equation, Basic PDE concepts; linearity and homogeneity, Separation of variables and Fourier series, Sturm-Liouville problems and special functions, The linear wave equation, Types of PDEs (parabolic, hyperbolic, elliptic), Partial derivatives, Implicit Functions, Vector space, Inner-product and Cross-product , Vector and Scalar Functions and Fields, Curves, parametric representation, tangent, arc-length, Gradient and Directional Derivative of Scalar Fields, Divergence and Curl of Vector Fields, Line Integrals, Path-independence properties , Multiple Integrals, Change of variables, Jacobians, Green's Theorem, parametric representation of Surfaces , Tangent plane and Normal, Surface Integrals , Volume Integrals, Gauss' Divergence Theorem, Stoke's Theorem

314. EEE611 Stochastic Processes 3(3,0)

Engineering applications of probability theory, Problems on events, independence, random variables, distribution and density functions, expectations, and characteristic functions, Dependence, correlation, and regression; multi-variate Gaussian distribution. Stochastic processes, stationarity, ergodicity, correlation functions, spectral densities, random inputs to linear systems, filtering of wide sense stationary processes, Wiener and Kalman filters. Markov processes and Markov chains, Gaussian, birth and death, poisson and shot noise processes. Elementary queuing analysis, Detection of signals in Gaussian and shot noise, elementary parameter estimation

315. EEE612 Discrete Mathematics 3(3,0)

Mathematical maturity appropriate to a sophomore math class. Logic, mathematical induction sets, relations, and functions. Introduction to graphs, elementary number theory, combinatorics, algebraic structures, discrete probability, theory, and statistics. Emphasis on topics of interest to students in computer engineering.

316. EEE613 Graph Theory 3(3,0)

The elements of the theory of graphs and directed graphs with motivating examples from communication networks, data structures, etc; shortest paths, depth first search, matching algorithms, parallel algorithms, minimum spanning trees, basic complexity theory, planarity, and other topics

317. EEE614 Engineering Optimization 3(3,0)

Linear Programming, Non Linear Programming, Gradient Method, Simplex Method, Dual Simplex Methods, Greedy Search, Convex optimization, Second Method, Lyapnov method, Constrained Optimization, Un Contained optimization, Genetic Algorithm, Binary Search

318. EEE615 Probabilistic Learning: Theory and Algorithms 3(3,0)

Analysis of correctness and complexity of various efficient algorithms, Deterministic and randomized graph algorithms, fundamental algorithmic techniques like divide-and-conquer strategies and dynamic programming, and NP-completeness, An introduction to probabilistic and statistical techniques for learning from data, including parameter estimation, density estimation, regression, classification, and mixture modeling.

319. EEE616 Optimization Theory 3(3,0)

Necessary and sufficient conditions for extrema, Newton Method, Constrained derivative (Jacobian) Method and its sensitivity analysis, Lagrangian method and its extension, Kuhn-Tucker conditions, Direct search method, Gradient method and reduced gradient method, Separable programming, Quadratic programming, Geometric programming, Linear combination method, Integer programming, Examples, Branch and Bound algorithm, Cutting-plane algorithm, Zero-One polynomial programming, Introduction to game theory.

320. EEE621 Modeling and Simulation 3(3,0)

Modeling and Simulation is a discipline for developing a level of understanding of the interaction of the parts of a system, and of the system as a whole. The level of understanding which may be developed via this discipline is seldom achievable via any other discipline. Introduction and basic simulation procedures. Model classification (with worded examples for each): Monte Carlo simulation, discrete-event simulation, continuous system simulation, mixed continuous/discrete-event simulation. Quantitative modelling paradigms: queueing networks, stochastic process algebras and stochastic Petri nets Input and output analysis: random numbers, generating and analyzing random numbers, sample generation, trace- and execution-driven simulation, point and interval estimation. Process-oriented and parallel and component simulation and modelling.

321. EEE630 Professional Development 3(3,0)

The overall aim of the program is to enable the student to achieve their potential and increase the performance of both themselves and their team members, both now and in the future. The objectives are to gain the essential awareness and skills necessary to fulfill responsibilities as a member of a team and potential team leader. By the end of the program the participant will: ? Become more aware of personality types, peoples? preferences, needs, motivations, and strengths ? Understand you own preferences & needs, and develop multi-step career/life goals ? Appreciate cultural diversity within teams; understand the role of a team member and team leader ? Have received a range of tools to help the participant to perform well within a team, and in their life ? Get a bigger picture of how organizations and people learn and develop ? Develop a career/life plan that combines your strengths, needs, to create credibility to achieve goals

322. EEE631 Professional and Technical Communication 3(3,0)

Grammar and Punctuation Review. Topics Covered: Commas, Semicolons, Apostrophes, Colons, Quotation Marks, Homonyms, Numbers, Capitalization, Misused Words. Writing Reports to Get Results. "The Report Writers; Pyramid", "Developing a Writing Style", and "Guidelines" covered. Business Letter Formats: Block, modified block, and business letters; Report Writing, Field Trip Reports, Inspection Reports; Progress Reports, Lab Reports, Short Investigation Reports; Long Investigation Reports; Research Reports and Reference Formats. MLA and APA styles; Resume Development/Cover Letter Writing; Public Speaking Units

323. EEE632 Research Methods 3(3,0)

Types of research, Simulation modeling, How to write research proposal, How to write technical papers, Data analysis techniques.

324. EEE640 Innovation and Technology Development 3(3,0)

The course examines technology management and innovation studies in order to understand the emergence, success and failure of technological systems, and explore the relevance to information systems implementation and management.

The course introduces different theoretical perspectives on innovation studies and technology management. Topics include: systems and management approaches to technology development, sociology of technology, science and technology studies. Technology case studies will be examined including software and information systems failures, IT expertise, decision-making, project escalation in information systems projects, and technology disasters.

325. EEE641 Sociological Impact of Technology 3(3,0)

Contemporary works in the sociology of Technology offer numerous critics of the classical divide between technical and social features. It has been shown that the Success or failure of technical innovations rests on their capacity to integrate various organizational and interactional features. This course aims at providing students with a general background in the sociology of ICTs. The main goal is to gain a better understanding of ICT's uses or resistance to change in firms. Various case studies of ICT's uses and innovations, either in professional or ordinary, mundane contexts, will be discussed. Drawing from those studies, the course presents an array of methods of methods for qualitative data collection and analysis.

326. EEE642 Science, Politics and Ethics 3(3,0)

This course focuses on the current issues relating to science and technology, political barriers in scientific research, political decision to accept and spread certain technologies and its impact on society.

327. EEE650 Project Management 3(3,0)

Introduction to Project Management, The Strategic Relevance of Project Management & Project Stakeholders, Project Organization, Project Selection & Portfolio Management, Project Methodology and Process Groups , The Project Initiation / Definition Phase, The Project Planning Phase I – The Work Breakdown Structure.; The Project Planning Phase II – Human Resource Issues, Costing, Risk Analysis, Project Partnering & Outsourcing; The Project Planning Phase III : Scheduling Project Activities, Project Implementation , Project Leadership, Communication & Teams, Project Monitoring, Evaluation and Control, Project Closure / Termination

328. EEE651 Engineering Project Management 3(3,0)

Introduction to Project Management, The Strategic Relevance of Project Management & Project Stakeholders, Project Organization, Project Selection & Portfolio Management, Project Methodology and Process Groups , The Project Initiation / Definition Phase, The Project Planning Phase I – The Work Breakdown Structure.; The Project Planning Phase II – Human Resource Issues, Costing, Risk Analysis, Project Partnering & Outsourcing; The Project Planning Phase III : Scheduling Project Activities, Project Implementation , Project Leadership, Communication & Teams, Project Monitoring, Evaluation and Control, Project Closure / Termination.

329. EEE690 Industrial Project-I 3(0,3)

Prerequisite: departmental approval. Program of work experience prescribed and approved by student's faculty coordinator. This industrial project involves work in an industry, enterprise or public/private organization that includes design/development/analysis in areas of study relevant to the academic program. Student will register with a faculty member as Departmental Advisor. An examining committee will be formed by the department that may include an external examiner. The student would be required to submit a written report within the department. An oral defense would also be held by the department.

330. EEE691 Independent Studies-I 3(0,3)

Prerequisite: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Student will register with a faculty member as Advisor. Evaluation will depend on the advisor. Generally evaluation will include submission of a written report within the department and an oral defense. An examining committee will be formed by the department that may include an external examiner. The advisor may ask for a written exam instead of a report and oral defense.

331. EEE692 Directed Study-I 3(0,3)

Prerequisite: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Student will register with a faculty member as Advisor. Evaluation will depend on the advisor. Generally evaluation will include submission of a written report within the department and an oral defense. An examining committee will be formed by the department that may include an external examiner. The advisor may ask for a written exam instead of a report and oral defense.

332. EEE710 Advanced Engineering Mathematics 3(3,0)

Topics will chosen by the instructor with the consent of the departmental graduate committee based on the requirements of the program of study for developing the requisite mathematical basis of the students.

333. EEE711 Advanced Stochastic Processes 3(3,0)

Engineering applications of probability theory, Problems on events, independence, random variables, distribution and density functions, expectations, and characteristic functions, Dependence, correlation, and regression; multivariate Gaussian distribution, Stochastic processes, stationarity, ergodicity, correlation functions, spectral densities, random inputs to linear systems, filtering of wide sense stationary processes, Wiener and Kalman filters. Markov

processes and Markov chains, Gaussian, birth and death, poisson and shot noise processes. Elementary queuing analysis, Detection of signals in Gaussian and shot noise, elementary parameter estimation

334. EEE712 Optimization Techniques 3(3,0)

Topics covered in this course are: Classical Optimization Techniques with equality constraints (e.g. Lagrange Multipliers etc) for 1 variable, two variables and many variables, Linear Programming, Integer Programming, Assignment problem, Transportation problem, PERT, CPM, Misc. topics in optimization techniques

335. EEE714 Advanced Numerical Analysis 3(3,0)

Review of the basic concepts in numerical analysis with convergence and error estimates. Initial value problems, Euler method, Modified Euler method, multistep methods and their consistency, stability criteria and convergence. System of differential equations, Boundary value problems, finite difference methods, collocation methods, spline methods, Rayleigh-Ritz methods, Galerkin Methods.

336. EEE715 Numerical Linear Algebra 3(3,0)

Fundamentals: matrix multiplication, orthogonal vectors, orthogonal matrices, norms; Gaussian Elimination and its variants: Cholesky decomposition, LU decomposition, pivoting strategies; Sensitivity of linear systems: conditioning and stability; The least squares problem and SVD; Eigen values & Eigen vectors Ill-posedness & Regularization

337. EEE720 Modern Data Analysis Methods 3(3,0)

Use of computational and re-sampling techniques for data analyses wherein the data do not conform to standard toolbox of regression models and/or complexity of modeling problem threatens validity of standard method.

338. EEE721 Formal Specification and Modeling 3(3,0)

Examination of formal specification and modeling techniques, including algebraic, scenario-based, model-based, state-based, temporal and other logics, along with their related uses in software development.

339. EEE722 Computational Biology 3(3,0)

Aimed at those who are interested in learning about this interdisciplinary area. Introduction to computational methods in molecular biology, Computational approaches to understanding and predicting the structure, function, interactions, and evolution of DNA, RNA, proteins, and related molecules and processes.

340. EEE723 Biologically Inspired Computing 3(3,0)

This course surveys the state of the art in computing hardware and algorithms which are based on biological counterparts. Course topics include machine intelligence, neural networks, artificial sensing and perception, genetic algorithms and systems, as well as novel technologies such as neuro-electrical interfaces. The prerequisite for this course is at least one course in machine learning, neural networks, or artificial intelligence.

341. EEE730 Advanced Professional Development 3(3,0)

Advanced topics of current interest in Professional Development which are taken from current research topics and technical publications.

342. EEE740 Advanced Electrochemistry 3(3,0)

The intent of this class is to provide students with a strong foundation in electrochemical material science. It will emphasize corrosion science with focus on the thermodynamics, electrochemical kinetics, transport phenomena in electrochemistry, and passivity followed by the phenomenological observations, basic theory and latest mechanisms associated with the eight forms of corrosion. The fundamental thermodynamics and kinetics will easily enable discussion of batteries and fuel cells, and to a limited extent plating and industrial electrochemical phenomena.

343. EEE741 Advanced Thermal Chemistry 3(3,0)

Advanced topics of current interest in Thermal Chemistry which are taken from current research topics and/or technical publications

344. EEE750 Power Sector Deregulation 3(3,0)

Fundamentals of Deregulation, International Experiences, Different Models of Deregulation. Reform of Electricity Supply Industry, Operational and Control, Wheeling Charges and Pricing; Power Sector Economics: Depreciation, profitability indices, Capital cost, life cycle cost, Tariff Rate structure. Performance of indices of power utility; Performance indices for different aspects power utility such as generation, transmission, distribution, metering, billing, costs, power quality & consumer service. Demand side management(DSM) & Integrated resource planning(IRP), Integrated Resource Planning:- Conceptual Issues & methodology. Power Sector In Pakistan: Evaluation of integrated, monopoly, state owned electricity boards, Challenges in power sector for Planning commission/Ministries. Power sector restructuring : Ownership model (Public sector state owned and municipal utilities , joint sector , cooperatives and private sector). Review of International experience of Restructuring :- Rational for restructuring structural and ownership changes , outcomes technological aspects of restructuring , Impact of Power Sector restructuring on DSM , IRP , and Regulation. Overview of legal framework governing International/Pakistani Power Sector.

345. EEE751 Project Feasibility Study 3(3,0)

Preparation of a feasibility study, Study of project and optimization, Exploration of the best possible alternatives in any project, How to effectively predict the project schedule. How to comprehensively analyze your market. How to properly predict your financial requirements. How to write, prepare and produce a professional Feasibility Study report.

You will be able to prepare a study that will impress your bank, your colleagues.

You will also learn how to: Work out project returns using various methods how to alter your plans to maximize them. Use critical and sensitivity analysis to improve your plans and projections. Pull someone else's feasibility study apart and find its weaknesses. Avoid others criticizing and doing this to your reports. Earn money doing Feasibility reports for others.

346. EEE790 Industrial Project-II 3(0,3)

Prerequisite: departmental approval. Program of work experience prescribed and approved by student's faculty coordinator. This industrial project involves work in an industry, enterprise or public/private organization that includes design/development/analysis in areas of study relevant to the academic program. Student will register with a faculty member as Departmental Advisor. An examining committee will be formed by the department that may include an external examiner. The student would be required to submit a written report within the department. An oral defense would also be held by the department.

347. EEE791 Independent Studies-II 3(0,3)

Prerequisite: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Student will register with a faculty member as Advisor. Evaluation will depend on the advisor. Generally evaluation will include submission of a written report within the department and an oral defense. An examining committee will be formed by the department that may include an external examiner. The advisor may ask for a written exam instead of a report and oral defense.

348. EEE792 Directed Study-II 3(0,3)

Prerequisite: departmental approval. Program of study prescribed and approved by student's faculty coordinator. This special course covers areas of study in which one or more students may be interested but is not of sufficiently broad interest to warrant a regular course offering. Student will register with a faculty member as Advisor. Evaluation will depend on the advisor. Generally evaluation will include submission of a written report within the department and an oral defense. An examining committee will be formed by the department that may include an external examiner. The advisor may ask for a written exam instead of a report and oral defense.

349. EEE899 PhD Thesis 9(0,9)

Required of all students working toward the Ph.D. in Electrical Engineering.