

New Curriculum for M.Tech. in Communications Engineering

Overall credit structure

Category	PC	PE	OE	Total
Credits	24	18	6	48

Semester wise distribution of credits

Semester	Courses					Lecture Courses	Contact hours/week				Credits
							L	T	P	Total	
I	(PC) ELL 711 <i>Signal theory</i> (3-0-0)	(PC) ELL712 <i>Digital Comm.</i> (3-0-0)	(PC) ELL 713 <i>Microwave Theory and Techniques</i> (3-0-0)	(PC) ELP 719 <i>Microwave Lab.</i> (0-1-4)		3	9	1	4	14	12
II	(PC) ELL719 <i>Detection and Estimation Theory</i> (3-0-0)	(PC) Wireless Comm. Lab. ELP725 (0-1-4)	PE (3-0-0)	PE (3-0-0)		3	9	1	4	14	12
SUMMER											
III	(PC) ELD811 <i>Major Project Part 1</i> (0-0-12)		PE (3-0-0)	OE (3-0-0)		2	6	0	12	18	12
IV (Project based)	(PE) ELD812 <i>Major Project Part 2</i> (0-0-24)					0	0	0	24	24	12
IV (Course based)	PE (3-0-0)	PE (3-0-0)	PE (3-0-0)	OE (3-0-0)		4	12	0	0	12	12

Programme Core (PC)

Course Number	Title	L-T-P	Credit
ELD811	Major Project Part-I (Communication Engineering)	0-0-12	6
ELL711	Signal Theory	3-0-0	3
ELL713	Microwave Theory and Techniques	3-0-0	3
ELL712	Digital Communications	3-0-0	3
ELL719	Detection and Estimation Theory	3-0-0	3
ELP719	Microwave Laboratory	0-1-4	3
ELP725	Wireless Communication Laboratory	0-1-4	3

Programme Elective (PE)

Students are strongly advised to select all their PE courses from either of the two specializations (SPL1 and SPL2) listed below.

Course Number	Title	L-T-P	Credit
	SPL 1: Communication Systems		
ELD810	Minor Project (Communication Engineering)	0-0-6	3
ELD812	Major Project Part-II	0-0-24	12
ELL710	Coding Theory	3-0-0	3
ELL717	Optical Communication Systems	3-0-0	3
ELL714	Basic Information Theory	3-0-0	3
ELL701	Mathematical Methods in Control	3-0-0	3
ELL813	Advanced Information Theory	3-0-0	3
ELL720	Advanced Digital Signal Processing	3-0-0	3
ELL814	Wireless Optical Communications	3-0-0	3
ELL818	Telecommunication Technologies	3-0-0	3
ELL725	Wireless Communications	3-0-0	3
ELL723	Broadband Communication Systems	3-0-0	3
ELL815	MIMO Wireless Communications	3-0-0	3
ELL816	Satellite Communication	3-0-0	3
ELP718	Telecommunication Software Laboratory	0-1-4	3
ELP721	Embedded Telecommunication Systems Laboratory	0-1-4	3
ELL785	Computer Communication Networks	3-0-0	3
ELL894	Network Performance Modeling and Analysis	3-0-0	3
ELL716	Telecommunication Switching and Transmission	3-0-0	3
CRL708	Sonar Systems Engineering	3-0-0	3
CRL709	Underwater Electronic Systems	3-0-0	3
ELL722	Antenna Theory and Techniques	3-0-0	3
ELL724	Computational Electromagnetics	3-0-0	3
ELL812	Microwave Propagation and Systems	3-0-0	3
CRL715	Radiating Systems for RF Communication	3-0-0	3
ELV710	Special Module in Cyber Security	1-0-0	1
ELL810	Cyber Security and Information Assurance	3-0-0	3

ELL732	Microelectronics	3-0-0	3
ELL734	MOS VLSI	3-0-0	3
CRL712	RF and Microwave Active Circuits	3-0-0	3
ELL730	I.C. Technology	3-0-0	3
ELL833	CMOS RF IC Design	3-0-0	3
ELL735	Analog Integrated Circuits	3-0-0	3
ELL821	Selected Topics in Communication Systems and Networking-I	3-0-0	3
ELL822	Selected Topics in Communication Systems and Networking-II	3-0-0	3
ELV720	Special Module in Communication Systems and Networking - I	1-0-0	1
ELV821	Special Module in Communication Systems and Networking - II	1-0-0	1
	SPL2: Information Processing		
ELD810	Minor Project (Communication Engineering)	0-0-6	3
ELD812	Major Project Part-II	0-0-24	12
CRL704	Sensor Array Signal processing	3-0-0	3
CRL707	Human and Machine Speech Communication	3-0-0	3
ELL786	Multimedia Systems	3-0-0	3
ELL784	Introduction to Machine Learning	3-0-0	3
ELL710	Coding Theory	3-0-0	3
ELL714	Basic Information Theory	3-0-0	3
ELL715	Digital Image Processing	3-0-2	4
ELL718	Statistical Signal Processing	3-0-0	3
ELL701	Mathematical Methods in Control	3-0-0	3
ELL720	Advanced Digital Signal Processing	3-0-0	3
ELL792	Computer Graphics	3-0-0	3
ELL793	Computer Vision	3-0-0	3
ELL794	Human-Computer Interface	3-0-0	3
ELL823	Selected Topics in Information Processing-I	3-0-0	3
ELL824	Selected Topics in Information Processing-II	3-0-0	3
ELV781	Special Modules in Information Processing-I	1-0-0	1
ELV823	Special Modules in Information Processing-II	1-0-0	1

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Minor Project in Communication Engineering
3.	L-T-P structure	0-0-6
4.	Credits	3
5.	Course number	ELD810
6.	Status (<i>category for program</i>)	PE for EEE

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Major Project Part-I
3.	L-T-P structure	0-0-12
4.	Credits	6
5.	Course number	ELD811
6.	Status (<i>category for program</i>)	PROGRAM CORE for EEE program

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Major Project Part-II
3.	L-T-P structure	0-0-24
4.	Credits	12
5.	Course number	ELD812
6.	Status (<i>category for program</i>)	PE for EEE

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (indicate program names)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	CODING THEORY
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL710
6.	Status (<i>category for program</i>)	PE for EEE Program

7.	Pre-requisites (course no./title)	ELL 311 (Communication Engineering) for Dual Degree/B.Tech students
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Ranjan Bose, Manav Bhatnagar, Saif K. Mohammed
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): To provide an introduction to traditional and modern coding theory. Topics covered include Measure of information, Source coding, Communication channel models, Channel Capacity and coding, Linear Block codes, Low Density Parity Check (LDPC) Codes, Cyclic codes, BCH	
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	codes, Reed Solomon Codes, Convolutional codes, Trellis coded Modulation, Introduction to Space-Time Codes and Introduction to Cryptography.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Measure of information, Source coding, Communication channel models, Channel Capacity and coding, Linear Block codes, Low Density Parity Check (LDPC) Codes, Bounds on minimum distance, Cyclic codes, BCH codes, Reed Solomon Codes, Convolutional codes, Trellis coded Modulation, Viterbi decoding, Turbo codes, Introduction to Space-Time Codes and Introduction to Cryptography. If time permits, LDPC/Turbo codes in the wireless standards. There are no laboratory or design activities involved with this course.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1.	Source Coding	4
2.	Reliable Communication through Noisy Channels	4
3.	Linear Block Codes	6
4.	Cyclic Codes	5
5.	Bose Chaudhuri Hocquenghem (BCH) Codes	5
6.	Convolutional Codes	5
7.	Trellis Coded Modulation (TCM)	4
8.	Introduction to Space-Time Codes	4
9.	Cryptography	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	NA	

18. Brief description of module-wise activities pertaining to self-study component
(mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Basics of probability theory	3
2	Continuous random variables	2
3	Theory of large numbers	2
4	Matrix Theory	3
5	Polynomials and operations with polynomials	3
6	Finite fields, Galois Fields	4

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Textbook:

1. Ranjan Bose, Information Theory, Coding and Cryptography, 2nd Ed., Tata McGraw-Hill, 2008.

Reference:

1. T. M. Cover and J. A. Thomas, Elements of Information Theory, 2nd Ed., John Wiley & Sons, New Jersey, USA, 2006.
2. Shu Lin and Daniel Costello, Error Control Coding, 2nd Ed., by Pearson, 2004.
3. Rudiger Urbanke and Thomas Richardson, Modern coding theory, Cambridge, 2008.

Additional Reading:

1. F. J. MacWilliams and N. J. A. Sloane, The theory of error-correcting codes, North-Holland publishers, 1978.
2. Richard Blahut, Algebraic codes for data transmission, Cambridge University Press, 2003.
3. Bruce Schneier, Applied Cryptography, Second Edition, John Wiley & Sons, 1996.

20. Resources required for the course (itemized & student access requirements, if any)

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA
20.5	Equipment	NA
20.6	Classroom infrastructure	NA

20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course*(Percent of student time with examples, if possible)*

21.1	Design-type problems	NA
21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering (EE)
2.	Course Title (<i>< 45 characters</i>)	Signal Theory
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL711
6.	Status (<i>category for program</i>)	Program Core for EEE (M.Tech in Communications Engineering)

7.	Pre-requisites (<i>course no./title</i>)	For B.Tech/Dual Degree students: ELL105 (Signal and Systems), ELL311 (Communication Engineering)
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Ranjan K. Mallik, Saif Khan Mohammed, S. D. Joshi, Manav R. Bhatnagar, Shankar Prakriya, Ranjan Bose,
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): Teach some advanced aspects of signals in communication systems
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14.	Course contents (about 100 words) (Include laboratory/design activities): Discrete random variables (Bernoulli, binomial, Poisson, geometric, negative binomial, etc.) and their properties like PDF, CDF, MGF. Continuous random variables: Gaussian, multivariate Gaussian; whitening of the Gaussian random vector; complex Gaussian random vector, circularity; Rayleigh and Rician; exponential; chi-squared; gamma. Signal spaces: convergence and continuity; linear spaces, inner product spaces; basis, Gram-Schmidt orthogonalization. Stochastic convergence, law of large numbers, central limit theorem. Random processes: stationarity; mean, correlation, and covariance functions, WSS random process; autocorrelation and cross-correlation functions; transmission of a random process through a linear filter; power spectral density; white random process; Gaussian process; Poisson process.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Deterministic and random signals	2
2	Discrete random variables (Bernoulli, binomial, Poisson, geometric, negative binomial, etc.) and their properties like PDF, CDF, MGF	8
3	Continuous random variables: Gaussian, multivariate Gaussian; whitening of the Gaussian random vector; complex Gaussian random vector, circularity; Rayleigh and Rician distributions; exponential, chi-squared, and gamma distributions	10
4	Signal spaces: convergence and continuity; linear spaces, inner product spaces; basis, Gram-Schmidt orthogonalization	6
5	Stochastic convergence, law of large numbers, central limit theorem	6
6	Random processes: stationarity; mean, correlation, and covariance functions, WSS random process; autocorrelation and cross-correlation functions; transmission of a random process through a linear filter; power spectral density; white random process; Gaussian process; Poisson process	10
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	NA	

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
	Problem assignments and Matlab assignments will be given on topics covered in the course	42

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Text:

A. Papoulis and S. U. Pillai, "Probability, Random Variables, and Stochastic Processes," 4th edition, New York, NY: McGraw-Hill, 2002

Reference:

L. E. Franks, "Signal Theory," Englewood Cliffs, NJ: Prentice-Hall, 1969

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA

20.5	Equipment	NA
20.6	Classroom infrastructure	Classroom with OHP facility (capacity > 80)
20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	NA
21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Digital Communications
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL712
6.	Status (<i>category for program</i>)	Program Core for EEE Program

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	30% with UG course on Dig. Comm.
8.2	Overlap with any UG/PG course of other Dept./Centre	-
8.3	Supersedes any existing course	-

9.	Not allowed for (<i>indicate program names</i>)	-
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Swades De, ManavBhatnagar, Saif Khan Mohammed, Shankar Prakriya
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives <i>(about 50 words):</i> Strong theoretical foundation in digital communications and analysis of performance, evaluation of link performance, appreciate modern communication standards.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of random variables and random process, signal space concepts, Common modulated signals and their power spectral densities, Optimum receivers for Gaussian channels, Coherent and non-coherent receivers and their performance (evaluating BER performance through software tools), Basics of Information theory, source and channel coding, capacity of channels, band-limited channels and ISI, multicarrier and spread-spectrum signaling, multiple access techniques
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	Random Variables and random process	3
2.	Signal Space concepts	3
3.	Characterization of Modulated signals including PSDs	8
4.	Coherent and non-coherent receivers and their performance	11
5.	Signalling for bandlimited channels	3
6.	Basics of Information Theory, Capacity of Channels	4
7.	Receivers for channels with inter-symbol interference	4
8.	Coding theory	4
9.	Communication over fading channels	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1.	Review of elementary random variables and random process and probability theory	3
2.	Review of Vector spaces	3
3.	Modulation techniques used in different standards	3
4.	MATLAB study of performance of signaling techniques	5
5.	Study of telephone line channels and equalization techniques	3
6.	MATLAB study of capacity	4
7.	Study of ML and approximate ML techniques, sphere decoding	3
8.	Simulation study of performance of coding techniques	3
9.	Simulation study of performance in fading channels, different fading models, Jakes model	3

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. John G Proakis and Salehi, Digital Communication, Fifth Edition, McGraw-Hill, 2007.
2. John R. Barry, Edward A. Lee, David G. Messerschmitt, Digital Communications, Springer, third edition, 2004.

20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	MATLAB for assignments/self-study component
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	Projector
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Microwave Theory and Techniques
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL713
6.	Status (<i>category for program</i>)	PROGRAM CORE for EEE program

7.	Pre-requisites (<i>course no./title</i>)	For B.Tech/Dual Degree students: ELL212 (Engineering Electromagnetics)
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	15% , CRL711
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	N/A
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Dr. Kushal Shah Dr. UdayKhankhoje Prof. AnanjanBasu Dr. Mahesh Abegaonkar Prof S K Koul
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives <i>(about 50 words):</i> The purpose of this course is to give an introduction to the basics of microwave circuits to the students.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of EM theory: Maxwell's equations, plane waves in dielectric and conducting media, energy and power. Transmission lines and waveguides: closed and dielectric guides, planar transmission lines and optical fibre. Network analysis: scattering matrix other parameters, signal flow graphs and network representation. Impedance matching and tuning. Analysis of planar transmission lines. Analysis of design of passive components.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Maxwell's equations	4
2	Transmission line theory	6
3	Impedance matching and Smith Chart	6
4	Plane waves (lossy and lossless), Poynting Vector	6
5	Reflection and refraction of plane waves	4
6	S Parameters	6
7	Waveguides	6
8	Surface waves	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities: N/A

17. Brief description of laboratory activities N/A

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

The material given as a part of this component depends on the ability and interest of each student and hence will vary substantially across students. Hence, its not possible to give a uniform module-wise description of this component.

Module no.	Description	No. of hours
1.	Assignment on electrostatics and vector algebra	7
2.	Assignment on scattering of plane waves	7
3.	Assignment on distributed circuits	7
4.	Assignment on waveguides	7

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

David Pozar, Microwave Engineering, 3rd Edition, Wiley India Pvt Ltd, 2012

20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	NIL
20.2	Hardware	NIL
20.3	Teaching aides (videos, etc.)	NIL
20.4	Laboratory	NIL
20.5	Equipment	NIL
20.6	Classroom infrastructure	Basic classroom infrastructure
20.7	Site visits	NIL
20.8	Others (please specify)	NIL

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	NIL
21.2	Open-ended problems	NIL
21.3	Project-type activity	NIL
21.4	Open-ended laboratory work	NIL
21.5	Others (please specify)	NIL

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	BASIC INFORMATION THEORY
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	ELL714
6.	Status (<i>category for program</i>)	PE for EEE Program

7.	Pre-requisites (<i>course no./title</i>)	For UG students ELL105 (Signal and Systems)
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course MANAV BHATNAGAR/SAIF K. MOHAMMED
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): This course is aimed for conveying basics of the information theory. This course provides in-depth understanding of the basic concepts like asymptotic equipartition property, entropy rate for a random process, proofs of Shannon capacity theorems, capacity of Gaussian channels, rate-distortion theory, and
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	data compression.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to entropy, relative entropy, mutual information, fundamental inequalities like Jensen's inequality and log sum inequality. Proof of asymptotic equipartition property and its usage in data compression. Study of entropy rates of the stochastic process following Markov chains. Study of data compression: Kraft inequality and optimal source coding. Channel capacity: symmetric channels, channel coding theorem, Fano's inequality, feedback capacity. Differential entropy. The Gaussian channel: bandlimited channels, channels with colored noise, Gaussian channels with feedback. Detailed study of the rate-distortion theory: rate distortion function, strongly typical sequences, computation of channel capacity. Joint source channel coding/separation theorem. There are no laboratory or design activities involved with this course.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to entropy, relative entropy, mutual information, fundamental inequalities	3
2	Asymptotic equipartition property	4
3	Entropy rates of stochastic process	4
4	Data compression	6
5	Differential entropy	3
6	Channel capacity	8
7	The Gaussian channel	7
8	Rate distortion theory	8
COURSE TOTAL (14 times 'L')		43

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
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17. Brief description of laboratory activities

Module no.	Description	No. of hours
	NA	

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Basics of probability theory	3
2	Theory of large number	2
3	Markov chain, Markov process	3
4	Source coding	5
6	Continuous random variables	3
7	Gaussian random variables, exponential random variable	4
8	Quantization of random variable	5

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

T. M. Cover and J. A. Thomas, Elements of Information Theory, 2nd ED., John Wiley & Sons, New Jersey, USA, 2006.

20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA
20.5	Equipment	NA
20.6	Classroom infrastructure	NA
20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	NA
21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Electrical Engineering	
2.	Course Title <i>(< 45 characters)</i>	Digital Image Processing	
3.	L-T-P structure	3-0-2	
4.	Credits	4	
5.	Course number	ELL715	
6.	Status <i>(category for program)</i>	PE for M.Tech in Communications (EEE) B.Tech, Dept. Elective for EL1	

7.	Pre-requisites <i>(course no./title)</i>	ELL205	
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8.	Status vis-à-vis other courses <i>(give course number/title)</i>	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	MAL715
8.3	Supersedes any existing course	None

9.	Not allowed for <i>(indicate program names)</i>	-
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course Prof SantanuChaudhury, Prof. S D Joshi, Dr. Brejesh Lall, Prof. Ranjan Bose, Dr. SumantraDutta Roy
12.	Will the course require any visiting faculty? No

13.	Course objectives <i>(about 50 words):</i> To equip students with understanding of digital image processing: image enhancement, restoration, reconstruction, segmentation and analysis.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to 2-D Signals and Systems. Image Digitization. Image Transforms. Image Enhancement: Image Restoration: Inverse Filtering, Algebraic Approach to Restoration, Wiener (LMS) approach, Constrained Least Squares Restoration, Adaptive methods for restoration. Image Reconstruction: The Filtered Back-Projection Algorithm, Algebraic Reconstruction Method. Image Segmentation: Detection of Discontinuities, Edge Linking and Boundary Detection, Thresholding, Region-Oriented Segmentation. Object representation and description: Boundary descriptors, region descriptors, HOG and SIFT based features. Colour Image processing: colour models, colour transformations, and processing techniques
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to 2-D Signals and Systems.	2
2	Image Digitization. Image Transforms.	4
3	Image Enhancement	6
4	Image Restoration	6
5	Image Reconstruction	4
6	Image Segmentation	8
7	Object representation and description	6
8	Colour image processing	6
COURSE TOTAL (14 times 'L')		42
16.	Brief description of tutorial activities: Tutorials are embedded in the Lectures.	

17. Brief description of laboratory activities

1	Project based implementation assignments	28
2		
3		
4		
5		

18. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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|--|
| 1. Digital Image Processing, 3rd Ed. (DIP/3e) by Gonzalez and Woods © 2008 |
| 2. Fundamentals of Digital Image Processing by Anil K. Jain, Prentice Hall, 1989 |

Resources required for the course (*itemized & student access requirements, if*

19. *any*)

19.1	Software	MATLAB, OpenCV
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	
19.7	Site visits	

20. Design content of the course (*Percent of student time with examples, if possible*)

20.1	Design-type problems	20%
20.2	Open-ended problems	10%
20.3	Project-type activity	20%
20.4	Open-ended laboratory work	
20.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Statistical Signal Processing
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL718
6.	Status (<i>category for program</i>)	PE for M.Tech program in Communication Engineering

7.	Pre-requisites (<i>course no./title</i>)	ELL 711 (Signal Theory) for M.Tech students
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	-
8.2	Overlap with any UG/PG course of other Dept./Centre	-
8.3	Supersedes any existing course	-

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course S D Joshi, Shankar Prakriya
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): Strong theoretical foundation for statistical characterization and analysis of signals, understanding performance of adaptive filtering algorithms.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of random variables, GS orthogonalization, geometric concepts, notions of projection, random processes, WSS processes, properties of autocorrelation and power spectral densities, properties of autocorrelation matrices, Cholesky decomposition, eigen-analysis, optimum Linear filtering, LMS and its performance, variants, Least-squares, QR decomposition and SVD, RLS and its performance, square-root RLS, Kalman Filters, spectrum modelling
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1.	Random variables, geometric concepts, GS orthogonalization	3
2.	Random process, autocorrelation and PSD	3
3.	Properties of autocorrelation matrices	3
4.	Optimum Linear Filtering	5
5.	LMS and its performance	4
6.	Least-squares	6
7.	SVD and QR decompositions	4
8.	RLS and its performance	4
9.	Kalman Filtering	6
10.	Spectrum modeling	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1.	Review of elementary random variables and probability theory	3
2.	Characterization of autocorrelation of measured random process	3
3.	Autocorrelation matrices of AR and noisy AR process	3
4.	Prediction of speech	3
5.	Echo-cancellation of speech	3
6	LS channel estimation	3
7.	SVD for precoding in communications	3
8.	RLS for channel estimation	3
9.	Kalman Filtering project	4
10.	Harmonic process and spectrum modelling	5

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- 1.Simon Haykin, "Adaptive Filter Theory," Pearson, fourth edition.
2. Monson Hayes, "Statistical Digital Signal Processing andModelling," Wiley, 2009.

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	MATLAB for assignments/self-study component
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	Projector
20.7	Site visits	
20.8	Others (please specify)	

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21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Detection and Estimation Theory
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL719
6.	Status (<i>category for program</i>)	Program Core for EEE (M.Tech. Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	ELL711 (Signal Theory) for M.Tech students
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course S.D.Joshi, Saif K. Mohammed, BrejeshLall, Shankar Prakriya
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): To familiarize the students with the classical statistical inference techniques and their applications to Communication and Signal Processing problems.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Overview of the course, Classical Decision Theory: Binary hypothesis testing: Bayes criterion, Neyman-Pearson criterion, min-max test, M-ary hypothesis testing: General rule, minimum probability of error decision rule, Gaussian case and associated geometric concepts, Erasure decision problem, Random parameter estimation. Non – random parameter estimation: CRLB for nonrandom parameters, ML estimation rule, asymptotic properties of ML estimates. Linear minimum variance estimation, Least squares methods CRLB for random parameter estimation, condition for statistical efficiency, Multiple parameter estimation, Composite and non-parametric hypothesis testing, Applications, Detection of signals, Mathematical preliminaries: K-L expansion and its application to Detection of known and un-known (i.e. with unknown, parameters) signals in AWGN., Detection of signals in colored noise. Linear estimation, Wiener filters and solution of Wiener Hopf Equations, Kalman-Bucy filters, Miscellaneous estimation techniques
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
	0. Overview of the course	1
	1.1 Classical Decision Theory: Binary hypothesis testing: Bayes criterion, Neyman-Pearson criterion, min-max test 1.2. M-ary hypothesis testing: General rule, minimum probability of error decision rule, Gaussian case and associated geometric concepts, Erasure decision problem	8
	Classical Estimation Theory 2.1. Random parameter estimation (estimates which require knowledge about pdf of parameter as well as noise): Bayes estimation setting, various cost functions and corresponding estimation rules, conditions for invariance of estimates to cost function. 2.2 Non – random parameter estimation (estimates which require knowledge about the pdf of noise only): CRLB for nonrandom parameters, ML estimation rule, asymptotic properties of ML estimates. 2.3 Linear minimum variance estimation (estimates which require knowledge of only first and second order statistics of parameter and noise) 2.4 Least squares methods (estimates based on only data) 2.5 CRLB for random parameter estimation, condition for statistical	13

	efficiency , estimation with Gaussian density function: Linear and non-linear observation , sequential estimation. 2.6 Multiple parameter estimation	
1.	Composite and non-parametric hypothesis testing	2
	Applications 4.1 Detection of signals 4.1.1 The general Gaussian problem. 4.1.2 Mathematical preliminaries: K-L expansion, eigenfunctions etc. 4.1.3 Detection of known and un-known (i.e. with unknown parameters) signals in AWGN. 4.1.4 Detection of signals in colored noise. 4.2 Linear estimation 4.2.1 Wiener filters and solution of Wiener Hopf Equations 4.2.2 Kalman-Bucy filters 4.2.3 Miscellaneous estimation techniques	16
	Special topics	2
	COURSE TOTAL (14 times 'L')	42

16. Brief description of tutorial activities: not applicable

Module no.	Description	No. of hours

17. Brief description of laboratory activities: Not Applicable

[illegible]

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
	Numerical as well computational assignment on Detection Theory	10
	Numerical as well computational assignment on Estimation Theory	10
	Term paper presentation on application of concepts learnt	10

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

(i)	Detection ,Estimation and Modulation Theory , Part I ,H. L. Van Trees.
(ii)	Decision and Estimation Theory , Melsa& Cohn , MGH publications.
(iii)	Detection of Signals in Noise , A.D. Whalen (Academic Press,1971).
(iv)	Recently published papers.

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	Access MATLAB
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	

20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Advanced Digital Signal Processing
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL720
6.	Status (<i>category for program</i>)	PE for EEE Program

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course Prof. Shankar Prakriya, Dr. BrejeshLall, Dr. Saif K. Mohammed, Prof. S D Joshi
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): To equip students with understanding of digital signal processing: design and analysis of filters.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of Signals and Systems, Sampling and data reconstruction processes. Z transforms. Discrete linear systems. Frequency domain design of digital filters. Quantization effects in digital filters. Discrete Fourier transform and FFT algorithms. High speed convolution and its application to digital filtering. Introduction to Multirate signal processing, Multirate filtering and Filterbanks: including Polyphase decomposition and perfect reconstruction, Cyclostationarity and LPTV filters, Introduction to Wavelet Transform. The self-study component will consist of design problems in the above to be implemented on MATLAB.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of Signals and Systems: Sampling, Z-transform and discrete linear systems.	5
2	Frequency domain design of digital filters	5
3	Quantization effects in digital filters	8
4	Discrete Fourier Transform and FFT	4
5	High speed convolution and its applications	4
6	Introduction to Multirate signal processing	2
7	Multirate filtering and Filterbanks: including Polyphase decomposition and perfect reconstruction	8
8	Cyclostationarity and LPTV filters	4
9	Introduction to Wavelet Transform	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
	Problem assignments and paper presentation will be given on topics covered in the course	42

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Discrete-Time Signal Processing, 3/E, Alan V. Oppenheim and Ronald W. Schafer
2. Digital Signal Processing, 3/e, Sanjit K Mitra

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering	
2.	Course Title (<i>< 45 characters</i>)	Digital Signal Processing-I	
3.	L-T-P structure	3-0-2	
4.	Credits	4	
5.	Course number	ELL720	
6.	Status (<i>category for program</i>)	PE for EEE Program	

7.	Pre-requisites (<i>course no./title</i>)	ELL105 (Signals and Systems) for B. Tech. Students
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course Prof. Shankar Prakriya, Dr. Brejesh Lall, Dr. Saif K. Mohammed, Prof. S D Joshi
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives (<i>about 50 words</i>): To equip students with understanding of digital signal processing: design and analysis of filters.
-----	---

14.	Course contents (about 100 words) (Include laboratory/design activities): Review of Signals and Systems, Sampling and data reconstruction processes. Z transforms. Discrete linear systems. Frequency domain design of digital filters. Quantization effects in digital filters. Discrete Fourier transform and FFT algorithms. High speed convolution and its application to digital filtering. The laboratory will consist of design problems in the above are to be implemented on MATLAB.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of Signals and Systems	5
2	Sampling and data reconstruction	3
3	Z-Transforms	4
4	Discrete linear systems	4
5	Frequency domain design of digital filters	5
6	Quantization effects in digital filters	10
7	Discrete Fourier Transform and FFT	4
8	High speed convolution and its applications	5
9	Introduction to Multirate signal processing	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours
1	Implementation exercises on MATLAB	8
2	Project on MATLAB	20

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
	Problem assignments and paper presentation will be given on topics covered in the course	42

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Discrete-Time Signal Processing, 3/E, Alan V. Oppenheim and Ronald W. Schafer
2. Digital Signal Processing, 3/e, Sanjit K Mitra

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	Electrical Engineering
2.	Course Title (<45 characters)	Introduction to Telecommunication Systems
3.	L-T-P Structure	3-0-0
4.	Credits	3
5.	Course Number	ELL721
6.	Status (category for program)	PE for Bharti JTM

7.	Pre-requisites (course no/title)	Only for MBA students of Bharti School, Audit for others
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8	Status vis-a-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supersedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1st sem ☐ 2nd sem ☒ Either sem
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11.	Faculty who will teach the course MANAV BHATNAGAR SHANKAR PRAKRIYA BREJESH LALL SHIV DUTT JOSHI
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Date:

(Signature of the Head of the Department)

12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (about 50 words): To provide a introduction to the area of telecom, protocols, transmission and signaling
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14.	Course contents (about 100 words) (Include laboratory/design activities): Fundamentals of signals, signal transmission and media, modulation techniques, equalization, amplification, crosstalk, attenuation, switching principles, telephony, signaling, transmission systems-DSL,optical,radio.
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
1	Fundamentals of signals	2
2	Signal transmission techniques	4
3	Transmission media	6
4	Modulation techniques	6
5	Equalization	2
6	Amplification	3
7	Switching	4
8	Telephony	6
9	Signaling	3
10	Transmission system-DSL, optical, radio	6
COURSE TOTAL (14 times `L')		42

Date:

(Signature of the Head of the Department)

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700/800 level courses)

Module no.	Description	No. of hours
1	Basics of Communication engineering	21
2	Modulation and transmission	21
3	Channels and their characteristics	21
4	Network characterization	14
5	Switching and signaling	14
6	Transmission links – DSL, radio, optical	21

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year

1. Simon S. Haykin, "Communication Systems", 4th Ed, John Wiley & Sons, 2000
2. G.Y.Kim, "Broadband LAN technology", Artech House, 1988

Date:

(Signature of the Head of the Department)

20. Resources required for the course*(itemised & student access requirements, if any)*

20.1	Software	Matlab
20.2	Hardware	PCs
20.3	Teaching aids (videos, etc.)	Multimedia projector, visualizer
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom Infrastructure	Classroom (to seat 50)
20.7	Site visits	
0.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	30%
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	Classes 70%

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	Antenna Theory and Techniques
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL 722
6.	Status (<i>category for program</i>)	Program Elective for EEE (M. Tech. in Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	
8.2	Overlap with any UG/PG course of other Dept./Centre	50% overlap with CRL 715 (Radiating System for RF communication floated by CARE). Student cannot be allowed to register for both.
8.3	Supersedes any existing course	

9.	Not allowed for (<i>indicate program names</i>)	Student who has already taken/registered for CRL715 (Radiating Systems for RF Communication)
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course: Uday Khankhoje, Mahesh Abegaonkar
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives <i>(about 50 words):</i> To understand the theoretical foundations of antenna theory and design by studying various antenna types, and to visualize their radiation patterns using numerical techniques.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of electromagnetism and vector calculus, history and context of antenna theory, operation of various antenna types, such as dipole, linear, loop, and resonant type, characterization of antenna performance metrics, and introduction to numerical techniques for visualizing antenna radiation patterns.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of electromagnetism and vector calculus	3
2	History of antennas and initial experiments of Hertz, Bose.	2
3	Auxiliary potential functions in electromagnetics	3

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Design of linear antennas	5
2	Design of microstrip antennas	5
3	Circuit models of transmitting and receiving antennas	4
4	Numerical exercises for simulating antenna structures	6
5		

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. BalanisC, Antenna Theory: Analysis and Design, 3rded, Wiley 3rd, 2005.
2. W. L. Stutzman and G. A. Thiele, Antenna Theory and Design, 2nd ed., Wiley, 1998

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	
20.2	Hardware	

20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	ADVANCED INFORMATION THEORY
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	ELL724
6.	Status (<i>category for program</i>)	PE for EEE Program

7.	Pre-requisites (<i>course no./title</i>)	ELL714 (Basic Information Theory)
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course SAIF KHAN MOHAMMED AND MANAV BHATNAGAR
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): This course is aimed for somebody who already understands basic information theory underlying single user, single antenna, non-fading communication links. The students will learn strategies for communicating reliably on a multi-user fading/non-fading channel with multiple antennas at the terminals. The key focus would be to understand the optimal communication strategies for various multi-user settings like the Multiple-Access Channel (MAC) and the
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	Broadcast channel (BC). Students would learn and understand the techniques used in the proof of achievability of rate regions (using random coding arguments), and also the proof style for the converse.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Capacity of single-user Gaussian multi-antenna deterministic channels and optimal strategies. Reliable transmission in single user state dependent channels. Capacity of Gaussian single-antenna fading channels with state (RX CSI, Full CSI). Capacity of single-antenna frequency-selective fading channels (OFDM modulation, waterfilling across frequency). Capacity of Gaussian multi-antenna single user fading channels (RX CSI only, Full CSI). Spatial multiplexing gain, array gain. Transmitter and receiver architectures, V-BLAST transmission, Zero-Forcing receiver, MMSE receiver, MMSE-SIC receiver. Optimality of MMSE-SIC. Capacity region of the multi-user Gaussian MAC channel. Capacity region of the multi-user Gaussian Broadcast channel (BC) with single-antenna terminals. Capacity of state dependent channels with non-causal side information (Gelfand-Pinsker coding). Dirty paper coding to pre-cancel known interference. MAC-BC duality. Capacity region of the multi-user Gaussian Broadcast channel with multi-antenna terminals (Dirty paper coding achieves the capacity region). Capacity region of the Interference channel. There are no laboratory or design activities involved in this course.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Capacity of single-user Gaussian multi-antenna deterministic channels and optimal strategies	3
2	Reliable transmission in single user state dependent channels. Capacity of Gaussian single-antenna fading channels with state (RX CSI, Full CSI)	4
3	Capacity of single-antenna frequency-selective fading channels (OFDM modulation, waterfilling across frequency)	2
4	Capacity of Gaussian multi-antenna single user fading channels (RX CSI only, Full CSI). Spatial multiplexing gain, array gain	3
5	Transmitter and receiver architectures, V-BLAST transmission, Zero-Forcing receiver, MMSE receiver, MMSE-SIC receiver. Optimality of MMSE-SIC	4
6	Capacity region of the Multiple Access channel (MAC)	4
7	Capacity region of the multi-user Gaussian Broadcast channel (BC) with single-antenna terminals	4
8	Capacity of state dependent channels with non-causal side information (Gelfand-Pinsker coding)	3
9	Dirty paper coding to pre-cancel known interference	3
10	MAC-BC duality	3

11	Capacity region of the multi-user Gaussian Broadcast channel with multi-antenna terminals (Dirty paper coding achieves the capacity region)	5
12	Capacity region of the multi-user Interference channel (IC), interference alignment.	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	Not Applicable	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	Not Applicable	

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Problem assignment on single-user Gaussian multi-antenna deterministic channels	5
2	Problem assignment on transmission strategies for state dependent channels	5
3	Matlab assignment on waterfilling in frequency selective channels	3
4	Problem assignment on spatial multiplexing and array gains	3
5	Matlab assignment demonstrating the performance achieved by various transceiver strategies	6
6,7	Problem assignments on capacity region of the MAC and BC channels	5
8,9	Problem assignment on dirty paper coding	4
	Understanding and presenting a research paper on topics covered in the course	20

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

A. E. GAMAL, Y.-H. KIM, Network Information Theory, 1ST ED., CAMBRIDGE UNIVERSITY PRESS, CAMBRIDGE, UK, 2011.

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20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA
20.5	Equipment	NA
20.6	Classroom infrastructure	NA
20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	NA
21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	Microwave Propagation and Systems
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL725
6.	Status (<i>category for program</i>)	PE for EEE (M.Tech. in Communication Engineering)

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course: Uday Khankhoje
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives <i>(about 50 words):</i> To understand wireless propagation from physical principles in the context of communication systems.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Frequency bands and allocations. Earth and its effects on propagation. Atmosphere and its effects on propagation. Attenuation of millimeter waves. Line-of-sight communication links: system configuration, multiplexing, link design. Troposcatter propagation and links: Fading and diversity reception, path profile and path loss, link design, signal design for fading channels.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Frequency bands and allocations.	2
2	Earth and its effects on propagation.	4
3	Atmosphere and its effects on propagation.	6
4	Attenuation of millimeter waves.	8
5	Line-of-sight communication links: system configuration, multiplexing, link design.	8
6	Troposcatter propagation and links: Fading and diversity reception, path profile and path loss, link design, signal design for fading channels.	8
7	Numerical techniques for simulating fading channels	6
8		

9		
10		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
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1		
2		
3		
4		
5		

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

http://www.crcpress.com/product/isbn/9781439878972

20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Wireless Communications
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL725
6.	Status (<i>category for program</i>)	PE for EEE (Mtech in Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	ELL712 (Digital Communications) for M.Tech students, (UG course on Digital Communications) for B.tech/Dual Degree students.
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Saif Khan Mohammed, Ranjan Bose, Manav R. Bhatnagar, Shankar Prakriya
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): To introduce students to theory, analysis and design of communication (systems) using EM waves.
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14.	Course contents (about 100 words) (Include laboratory/design activities): The wireless channel (physical modeling, linear time-varying system, discrete-time baseband model, time and frequency coherence), point-to-point communication (detection, diversity, spatial multiplexing), cellular systems (multiple access and interference management), capacity of point-to-point wireless channels (single and multi-antenna), capacity of single-antenna multiuser channels, point-to-point multi-antenna (MIMO) channels and spatial multiplexing, point-to-point MIMO capacity and multiplexing architectures.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	The wireless channel	4.5
2	Point-to-point communication (detection, diversity, spatial multiplexing)	6.0
3	Cellular systems	3.0
4	Capacity of point-to-point wireless channels (single and multi-antenna)	6.0
5	Capacity of single-antenna multiuser channels	7.5
6	Point-to-point multi-antenna (MIMO) channels and spatial multiplexing	7.5
7	Point-to-point MIMO capacity and multiplexing architectures	7.5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
	Problem and Matlab assignments on topics covered in lectures	42

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Tex Book: 1. David Tse and Pramod Viswanath, ``Fundamentals of Wireless Communication," Cambridge University Press, 2005.</li> </ol> <p>Reference Books:</p> <ol style="list-style-type: none"> <li>1. Andrea Goldsmith, ``Wireless Communications," Cambridge University Press, 2005. 2. Andreas F. Molisch, ``Wireless Communications," John Wiley and Sons, 2005, 2011.
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20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	
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20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	Cyber Security and Information Assurance
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL810
6.	Status (<i>category for program</i>)	PE for EEE (M. Tech. in communication Engn.)

7.	Pre-requisites (course no./title)	None
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Ranjan Bose
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): To develop an understanding of the principles underlying cyber security and information assurance. This course provides in-depth understanding of computer security, network security, wireless security, mobile security, hardware security and the security of cyber	
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	physical systems.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to cyber security, information assurance, computer security and the associated threat, attack, adversary models, identity representation, management and access control, intrusion detection, security at different levels: network, system, user, program security, network security, wireless security, mobile security, hardware security and the security of cyber physical systems.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1.	Introduction to cyber security and information assurance	2
2.	Threat, attack, adversary models	3
3.	Malicious logic and intrusion detection	4
4.	Identity representation and access control	4
5.	Network Security	6
6.	Wireless Security	5
7.	Mobile Security	4
8.	Hardware security	3
9.	Security of Cyber Physical Systems	4
10.	Introduction to cryptography	5
11.	Security Policies	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	NA	

18. Brief description of module-wise activities pertaining to self-study component
(mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1.	Basic cryptography	4
2.	Basics of Computer networks	4
3.	Basics of Wireless Communication	4

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Matt Bishop, Computer Security Art and Science, Addison Wesley, 2003

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA
20.5	Equipment	NA
20.6	Classroom infrastructure	NA
20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course (*Percent of student time with examples, if possible*)

21.1	Design-type problems	NA
21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	Microwave Propagation and Systems
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL812
6.	Status (<i>category for program</i>)	PE for EEE (M.Tech. in Communication Engineering)

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course: Uday Khankhoje
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12.	Will the course require any visiting faculty? (yes/no)	No
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13.	Course objectives <i>(about 50 words):</i> To understand wireless propagation from physical principles in the context of communication systems.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Frequency bands and allocations. Earth and its effects on propagation. Atmosphere and its effects on propagation. Attenuation of millimeter waves. Line-of-sight communication links: system configuration, multiplexing, link design. Troposcatter propagation and links: Fading and diversity reception, path profile and path loss, link design, signal design for fading channels.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Frequency bands and allocations.	2
2	Earth and its effects on propagation.	4
3	Atmosphere and its effects on propagation.	6
4	Attenuation of millimeter waves.	8
5	Line-of-sight communication links: system configuration, multiplexing, link design.	8
6	Troposcatter propagation and links: Fading and diversity reception, path profile and path loss, link design, signal design for fading channels.	8
7	Numerical techniques for simulating fading channels	6
8		

9		
10		
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
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1		
2		
3		
4		
5		

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

<http://www.crcpress.com/product/isbn/9781439878972>

20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Wireless Communications
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL812
6.	Status (<i>category for program</i>)	PE for EEE (Mtech in Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	ELL712 (Digital Communications) for M.Tech students, (UG course on Digital Communications) for B.tech/Dual Degree students.
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Saif Khan Mohammed, Ranjan Bose, Manav R. Bhatnagar, Shankar Prakriya
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): To introduce students to theory, analysis and design of communication (systems) using EM waves.
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14.	Course contents (about 100 words) (Include laboratory/design activities): The wireless channel (physical modeling, linear time-varying system, discrete-time baseband model, time and frequency coherence), point-to-point communication (detection, diversity, spatial multiplexing), cellular systems (multiple access and interference management), capacity of point-to-point wireless channels (single and multi-antenna), capacity of single-antenna multiuser channels, point-to-point multi-antenna (MIMO) channels and spatial multiplexing, point-to-point MIMO capacity and multiplexing architectures.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	The wireless channel	4.5
2	Point-to-point communication (detection, diversity, spatial multiplexing)	6.0
3	Cellular systems	3.0
4	Capacity of point-to-point wireless channels (single and multi-antenna)	6.0
5	Capacity of single-antenna multiuser channels	7.5
6	Point-to-point multi-antenna (MIMO) channels and spatial multiplexing	7.5
7	Point-to-point MIMO capacity and multiplexing architectures	7.5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
	Problem and Matlab assignments on topics covered in lectures	42

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Tex Book: 1. David Tse and Pramod Viswanath, ``Fundamentals of Wireless Communication," Cambridge University Press, 2005.</li> </ol> <p>Reference Books:</p> <ol style="list-style-type: none"> <li>1. Andrea Goldsmith, ``Wireless Communications," Cambridge University Press, 2005. 2. Andreas F. Molisch, ``Wireless Communications," John Wiley and Sons, 2005, 2011.
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20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	
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20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	MIMO Wireless Communications
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL815
6.	Status (<i>category for program</i>)	PE for EEE Program

7.	Pre-requisites (course no./title)	For U.G. students ELL105 (Signals and Systems) and ELL 311 (Communication Engineering)
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course ManavBhatnagar, Saif K. Mohammed, Ranjan Bose, Ranjan K. Mallik	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): To provide an introduction to multiple antennas based wireless communications. The course covers fundamentals of multiple-input multiple-output (MIMO) communication system. The basic quantities like diversity, coding gain, array gain are introduced. The error rate of the	
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	MIMO systems is analyzed in detail. The MIMO information theory is also covered. The concept of transmit and receive diversity, beamforming and combining, and space-time block code are also thoroughly explained. The precoder design and multiuser MIMO is also covered.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to space-time diversity, MIMO channel, MIMO information theory, error probability analysis, transmit diversity and space-time coding, linear STBC design, differential coding for MIMO, precoding, multiuser MIMO There are no laboratory or design activities involved with this course.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1.	Introduction to space-time diversity	3
2.	MIMO channel	3
3.	MIMO information theory	5
4.	Error probability analysis	6
5.	Transmit diversity and space-time coding	6
6.	Linear STBC design	6
7.	Differential coding for MIMO	5
8.	Precoding	4
9.	Multiuser MIMO	4
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	NA	

18. Brief description of module-wise activities pertaining to self-study component

(mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Basics of probability theory	3
2	Continuous random variables	3
3	Error analysis for single antenna based communication systems	5
4	Matrix Theory	5
5	Basics of information theory	6
6	Communication channels	4

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Textbook:

1. E. G. Larsson and P. Stoica, Information Theory, Space-Time Block Coding for Wireless Communications, Cambridge University Press, 2003.

Reference:

1. A. Paulraj, R. Nabar and D. Gore, Introduction to Space-Time Wireless Communications, Cambridge Univ. Press, 2003.

20. Resources required for the course (itemized & student access requirements, if any)

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA
20.5	Equipment	NA
20.6	Classroom infrastructure	NA
20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	NA
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21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	Satellite Communication
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL816
6.	Status (<i>category for program</i>)	PE for EEE Program

7.	Pre-requisites (course no./title)	For U.G. students ELL105 (Signals and Systems), ELL 311 (Communication Engineering)
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Manav Bhatnagar
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): This course aims at providing thorough information of the conventional and upcoming satellite communication technology. The course covers the fundamental aspects of the satellite communications like orbital theory and link budget analysis. The course would be taught from	
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	physical layer signal processing point-of-view and it would cover teaching of famous channel model of the land mobile satellite (LMS) links and also some recently discovered channel models. The multiple antennas based satellite communication would also be explained. The hybrid satellite-terrestrial satellite communication technology would also be introduced.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to satellite communication and orbital theory, satellite antennas, satellite link design, channel models for satellite links, modulation, multiple access techniques for satellite communication, VSAT, introduction to MIMO systems and error analysis, multiple antenna based satellite communication, hybrid satellite-terrestrial communication system There are no laboratory or design activities involved with this course.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1.	Introduction to satellite communication and orbital theory	5
2.	Satellite antennas	2
3.	Satellite link design	6
4.	Channel models for satellite links	6
5.	Modulation, multiple access techniques for satellite communication, and VSAT	6
6.	Introduction to MIMO systems and error analysis	6
7.	Multiple antenna based satellite communication	6
8.	Hybrid satellite-terrestrial communication system	5
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	NA	

18. Brief description of module-wise activities pertaining to self-study component
(mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Basics of orbital theory	3
2	Antenna fundamentals	3
3	Noise sources	3
4	Analog and digital modulation	6
5	Probability of error analysis for communication systems	6
6	Communication channels	4

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Textbook:

1. T. Pratt, C. Bostian, and J. Allnutt, Satellite Communications, 2nd ed. John Wiley & Sons, 2003.
2. K. Y. Jo, Satellite Communications Network Design and Analysis, ARTECH HOUSE, 2011.
3. Recent research papers on MIMO satellite and hybrid satellite-terrestrial communication

Reference:

1. E. G. Larsson and P. Stoica, Information Theory, Space-Time Block Coding for Wireless Communications, Cambridge University Press, 2003.

20. Resources required for the course (itemized & student access requirements, if any)

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA
20.5	Equipment	NA
20.6	Classroom infrastructure	NA
20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course*(Percent of student time with examples, if possible)*

21.1	Design-type problems	NA
21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Access Networks
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL817
6.	Status (<i>category for program</i>)	PE for Bharti JTM

7.	Pre-requisites (course no./title)	ELL818 Telecommunication Technologies Or ELL785 Computer Communication Networks
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (indicate program names)	Other than BhartiSchool /EE/CSE students
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☒ Either sem -
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11.	Faculty who will teach the course		
	Name	Contact address	email
	1. Dr. SubratKar	II-219 EE Dept	subrat@ee.iitd.ac.in
	2. BrejeshLall		

12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
	<u>Objectives</u> : To introduce the student to access networks and their design, management and operational principles.	

Date

Signature of Head of the Department

14.	Course contents (about 100 words) (Include laboratory/design activities): Contents: Types of access networks, wired (copper and optical) and wireless access networks, management, dimensioning and scaling of access networks, access network design.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Types of access networks and the OSI layer	12
2	Wired access – copper access networks	10
3	Wired access – optical access, PONs	10
4	Wireless access – lightweight protocols (Bluetooth 4.0 BLE)	4
5	Wireless access – DECT, GSM, CDMA, p-t-p links	4
6	Managing and designing access networks	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Types of access networks and the OSI layer	40
2	Wired access – copper access networks	20
3	Wired access – optical access, PONs	20
4	Wireless access – lightweight protocols (Bluetooth 4.0 BLE)	20
5	Wireless access – DECT, GSM, CDMA, p-t-p links	20
6	Managing and designing access networks	20
1	Types of access networks and the OSI layer	40
		180

Date

Signature of Head of the Department

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. (Ed.) Paul France, Local access network technologies, IEE Press, UK
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20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	Visualizer, Multimedia Projector
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	ONE , next to Laboratory
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date

Signature of Head of the Department

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (< 45 characters)	Telecommunication Technologies
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL818
6.	Status (category for program)	PE for EEE (M.Tech in Communication Engineering) and PC for Bharti JTM

7.	Pre-requisites (course no./title)	
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8.	Status vis-à-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	none
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (indicate program names)	Only for EEE and JTM
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course 1.Prof.SubratKar, EE Dept, subrat@ee.iitd.ac.in 2. Prof.V K Jain, EE Dept, vjain@ee.iitd.ac.in 3.Dr.S.Prakriya, EE Dept, shankar@ee.iitd.ac.in 4.Prof.B.Lall, EE Dept brejesh@ee.iitd.ac.in	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (about 50 words): Objectives: To provide a introduction to the area of telecom, protocols, transmission and signaling	
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Date

(Signature of the Head of the Department)

14.	Course contents (about 100 words) (Include laboratory/design activities): Contents: Types of Data Networks, types of access and edge networks, core networks, OSS/NMS and Telecom Management network (TMN), Teletraffic Theory and Network analysis
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Data networks and evolution of BISDN model	10
2	Access networks – copper, fiber and wireless access networks, xPON	10
3	Edge and Metro networks – BISDN, Carrier Ethernet	10
4	Core Networks – SDH and optical networks	6
5	OSS and TMN	6
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Data networks and evolution of BISDN model	30
2	Access networks – copper, fiber and wireless access networks, xPON	30
3	Edge and Metro networks – BISDN, Carrier Ethernet	30
4	Core Networks – SDH and optical networks	15
5	OSS and TMN	15
COURSE TOTAL (14 times 'L')		120

Date

(Signature of the Head of the Department)

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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|---|
| 1. B.A.Forouzan, "Data Communication & networking", 5/e or above, McGraw Hill, 2014 |
|---|

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	Multimedia projector
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	ONE – seating about 50 students
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (*Percent of student time with examples, if possible*)

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (< 45 characters)	Telecommunication Switching and Transmission
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL819
6.	Status (category for program)	PE for EEE and Bharti JTM

7.	Pre-requisites (course no./title)	ELL818 Telecom Technologies ELL785 Computer Communication Networks
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8.	Status vis-à-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supersedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course 1. Subrat Kar, EED 2. V.K.Jain, EED 3. Vinod Chandra , EED 4. Devi Chadha, EED	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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Date

(Signature of the Head of the Department)

13.	Course objectives <i>(about 50 words):</i> To familiarize students with the basics of Telecom transmission technologies in the access, edge and core networks and to introduce a mathematical basis to
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14.	Course contents (about 100 words) (Include laboratory/design activities): Wireline access circuits, long haul circuits, signaling, switching exchanges, analysis of telecom switching networks, teletraffic engineering, management protocols, multi-service telecom protocols and networks
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to access networks	6
2	Telephony and x-over-copper technologies	10
3	Alternative access technologies – xDSL, DECT, WLL, VoIP	10
4	Introduction to Signalling	4
5	Teletraffic engineering	6
6	Packet networks	4
7	OSS and NMS	2
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours

Date

(Signature of the Head of the Department)

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Introduction to access networks	20
2	Telephony and x-over-copper technologies	40
3	Alternative access technologies – xDSL, DECT, WLL, VoIP	40
4	Introduction to Signalling	30
5	Teletraffic engineering	40
6	Packet networks	10
7	OSS and NMS	20

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- “High-Performance Communications Networks”, Second Edition, Jean Walrand and PravinVaraiya, Morgan Kaufman Publishers
- W. Stallings, “Data and Computer Communications”, 6th edition, Prentice Hall, 2000. Good overview of communications systems, architectures and protocols.
- John Bellamy, Digital telephony, (3/e) John Wiley

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	Multimedia projector
20.4	Laboratory	
20.5	Equipment	
20.6	Classroom infrastructure	ONE

Date

(Signature of the Head of the Department)

20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Selected Topics in Communication Systems and Networking-I
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL821
6.	Status (<i>category for program</i>)	PE for EEE

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title <i>(< 45 characters)</i>	Selected Topics in Communication Systems and Networking-II
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL822
6.	Status <i>(category for program)</i>	PE for EEE

7.	Pre-requisites <i>(course no./title)</i>	
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8.	Status vis-à-vis other courses <i>(give course number/title)</i>	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for <i>(indicate program names)</i>	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives <i>(about 50 words):</i>	
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Selected Topics in Information Processing-I
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL823
6.	Status (<i>category for program</i>)	PE for EEE (M. Tech. in Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Selected Topics in Information Processing-II
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL824
6.	Status (<i>category for program</i>)	PE for EEE (M. Tech. in Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Telecommunication Software Laboratory
3.	L-T-P structure	0-1-4
4.	Credits	3
5.	Course number	ELP718
6.	Status (<i>category for program</i>)	PE for EEE, PC for Bharti JTM

7.	Pre-requisites (<i>course no./title</i>)	None
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
	Name	Contact address
	Email	
	1. Dr. SubratKarII-219 EE Deptsubrat@ee.iitd.ac.in	
	2. Prof.S.ChoudhuryEE Dept santanuc@ee.iitd.ac.in	

12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
	Objectives: To introduce the student to practical laboratory assignments with telecom protocol and simulation software and telecom software development processes and environments.	

Date

Signature of the Head of the Department

14.	Course contents (about 100 words) (Include laboratory/design activities): Contents: CASE tools, object-oriented program development, use of telecom network simulator, implementation using C/C++/Java, network management software design, V.5 test and simulation.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		14

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours
1	Software Development Life Cycle in Telecom	2
2	Software Tools and Tool-chains	3
3	Software Frameworks and Patterns	2
4	Implementation using UML	4
5	Service Delivery Architectures	2
6	Network Management Software	1
		14

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours

Date

Signature of the Head of the Department

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. Allen Tucker, Ralph Morelli, Chamindra de Silva
Software Development: An Open Source Approach
Chapman & Hall/CRC Innovations in Software Engineering and Software Development Series, 2011
2. A.Fisher, "CASE:Using Software Development Tools", John Wiley, 1991
3. Grady Booch, The UML User Guide, Pearson, 1999

20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	Unix-Ubuntu
20.2	Hardware	Personal Computers (one per student)
20.3	Teaching aides (videos, etc.)	Visualizer, Multimedia Projector
20.4	Laboratory	ONE -
20.5	Equipment	
20.6	Classroom infrastructure	ONE – for tutorials next to Laboratory
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date

Signature of the Head of the Department

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Microwave Laboratory
3.	L-T-P structure	0-1-4
4.	Credits	3
5.	Course number	ELP719
6.	Status (<i>category for program</i>)	PROGRAM CORE for EEE program

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	50% , CRL711
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Dr. Kushal Shah Dr. UdayKhankhoje Prof. AnanjanBasu Dr. Mahesh Abegaonkar Prof S K Koul	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives <i>(about 50 words):</i> The purpose of this course is to give an introduction to the basics of microwave circuit development and testing to the students.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Design, fabrication and testing of simple linear microwave circuits using microstrip technology.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours
1.	Vector Network Analyzer familiarization	4
2.	Smith Chart Review	4
3.	CAD Tools familiarization	4
4.	Photolithography	2

17. Brief description of laboratory activities N/A

Module	Description	No. of hours
1.	Microstrip lines	8
2.	Low-pass filter development	8

3.	Band-pass filter development	8
4.	Directional coupler development	8
5.	Power divider development	8
6.	Microstrip patch antenna development	8
7.	Lab Test	8

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours
1.	Vector Network Analyzer familiarization	4
2.	Smith Chart Review	4
3.	CAD Tools familiarization	4

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

David Pozar, Microwave Engineering, 3rd Edition, Wiley India Pvt Ltd, 2012

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	Free downloads
20.2	Hardware	Dielectric substrates, chemicals, microwave connectors
20.3	Teaching aides (videos, etc.)	NIL
20.4	Laboratory	Nothing special
20.5	Equipment	Vector network analyzer

20.6	Classroom infrastructure	Basic classroom infrastructure with projector
20.7	Site visits	NIL
20.8	Others (please specify)	NIL

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	30% (design of filter/coupler with given specifications)
21.2	Open-ended problems	NIL
21.3	Project-type activity	NIL
21.4	Open-ended laboratory work	NIL
21.5	Others (please specify)	NIL

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Telecommunication Networks Laboratory
3.	L-T-P structure	0-1-4
4.	Credits	3
5.	Course number	ELP720
6.	Status (<i>category for program</i>)	PC for Bharti JTM

7.	Pre-requisites (<i>course no./title</i>)	ELP718 Telecommunication Software Laboratory EEP780 Software Lab
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	None
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
	Name	Contact address
		Email
	1.Prof.SubratKar,BSTTM	subrat@ee.iitd.ac.in
	2.Prof.M.Bhatnagar EE Dept,	hmgupta@ee.iitd.ac.in
	3.Prof.B.Lall EE Dept	brejesh@ee.iitd.ac.in

12.	Will the course require any visiting faculty? (yes/no)	NO
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Date

Signature of the Head of the Department

13.	Course objectives <i>(about 50 words):</i> <u>Objectives:</u> Gives "hands-on" experience in telecom T&M through individual experiments and demonstrations.
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14.	Course contents (about 100 words) (Include laboratory/design activities): <u>Contents:</u> Development of network elements such as routers, SNMP nodes. Use of laboratory and telecom field test instruments such as: oscilloscopes, oscillators, RMS meters, transmission impairment measuring systems, return loss meters, etc. Enables students to study voice and data switching functions and to measure transmission and traffic characteristics on models of the major business communication systems and carrier transmission facilities (controlled LAN environments, Ethernet, E1, T1/T3lines). Experimental procedures include the use of frequency and time division multiplex systems and the modulation techniques employed by in such systems and the observation of noise and distortion effects.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	Embedded systems programming for network element functionality	4
	Use of laboratory and telecom field equipment	2
	Study of voice and data switching functions	2
	Measurement of transmission and carrier transmission characteristics	2
	Study of fdm/tdm systems	2
	Study of modulation techniques and noise/distortion effects	2
		14

Date

Signature of the Head of the Department

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

- | |
|--|
| 1. Stephen Mueller, "APIs and Protocols For Convergent Network Services", McGraw-Hill's Telecom Developer Series, Jan 2002 |
|--|

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	Unix, Windows
20.2	Hardware	Personal Computers / laptop
20.3	Teaching aides (videos, etc.)	Multimedia Projector, Visualizer
20.4	Laboratory	ONE
20.5	Equipment	Embedded / Single Board Computers, FPGA kits with network connectivity and peripherals, telecom T&M equipment for protocol sniffing, noise and crosstalk measurement, access link emulators
20.6	Classroom infrastructure	ONE, next to Laboratory
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (*Percent of student time with examples, if possible*)

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date

Signature of the Head of the Department

COURSE TEMPLATE

1.	Department/Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Wireless Communication Laboratory
3.	L-T-P structure	0-1-4
4.	Credits	3
5.	Course number	ELL725
6.	Status (<i>category for program</i>)	PC for EEE and Bharti

7.	Pre-requisites (course no./title)	ELL712
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Ranjan Bose, ManavBhatnagar, Saif K. Mohammed, Shankar Prakriya
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>): To give an introduction to the area of mobile communications at the Physical Layer and Data Link Control Layer. The laboratory will provide a hands-on experience to the students. Most of the experiments have been designed around the 2.4 GHz ISM band which does not require any specific license for operation.
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Date

Signature of the Head of the Department

14.	Course contents (about 100 words) (Include laboratory/design activities): Characterization of fading effects, Delay Spread Measurement, Fading counter- measures using Antenna diversity and Frequency diversity, Demonstration of Handover, Transmission of data over wireless communication link, Antenna half power beamwidth measurement, VSWR and impedance measurement of antennas, polarization of antennas, cross polar discrimination and polarization diversity, basic MIMO systems. The latter part of the lab course requires the students to do a project related to wireless communications.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
	NA	
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	

17. Brief description of laboratory activities

Module no.	Topic	No. of hours
1.	Characterization of fading effects	3
2.	Delay Spread Measurement	3
3.	Fading counter- measures using Antenna diversity	3
4.	Fading counter- measures using Frequency diversity	3
5.	Demonstration of Cellular Concept and Handover	3
6.	Transmission of data over wireless communication link	3
7.	Antenna half power beamwidth measurement	3
8.	Measurement of antenna characteristics	3
9.	Polarization of antennas, cross polar discrimination	3
10.	Communication using MIMO systems (SDR kits)	3
11.	Project work	12
COURSE TOTAL (14 times 'L')		42

Date

Signature of the Head of the Department

18. Brief description of module-wise activities pertaining to self-study component
(mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1.	Fading Channels	20
2.	Basics of antennas	20
3.	Cellular concept and Handover	20
4.	MIMO Systems	20
5.	Interference in wireless communications	10
6.	Space-Time codes	30
		120

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Text Book: 1. Ranjan Bose, Wireless Laboratory Manual, IIT Delhi 2008. Reference Books: 1. T. S. Rappaport, Wireless Communications: Principles and Practices, Prentice Hall, 2nd Edition, 2001. 2. D. Tse and P. Vishwanath, Fundamentals of Wireless Communication, Cambridge University Press, 2005 Additional Resources: 1. Ranjan Bose, Wireless Communications, NPTEL Video Lectures. 2002,

20. Resources required for the course (itemized & student access requirements, if any)

20.1	Software	Yes
20.2	Hardware	Yes
20.3	Teaching aides (videos, etc.)	Yes
20.4	Laboratory	Yes
20.5	Equipment	Yes
20.6	Classroom infrastructure	Yes , Classroom needed next to laboratory for tutorial
20.7	Site visits	No
20.8	Others (please specify)	No

Date

Signature of the Head of the Department

21. Design content of the course*(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

Date

Signature of the Head of the Department

COURSE TEMPLATE

1.	Department/Centre proposing the course	Electrical Engineering
2.	Course Title (<45 characters)	Advanced Telecommunications Networks Laboratory
3.	L-T-P Structure	0-1-4
4.	Credits	3
5.	Course Number	ELP821
6.	Status (category for program)	PE for Bharti JTM

7.	Pre-requisites (course no/title)	ELP720 Telecommunication Networks Laboratory
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8	Status vis-a-vis other courses (give course number/title)	
8.1	Overlap with any UG/PG course of the Dept./Centre	
8.2	Overlap with any UG/PG course of other Dept./Centre	
8.3	Supersedes any existing course	

9.	Not allowed for (indicate program names)	
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10.	Frequency of offering	☐ Every sem ☐ 1st sem ☐ 2nd sem ☒ Either sem
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11.	Faculty who will teach the course SUBRAT KAR SANTANU CHAUDHURY	
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Date:

(Signature of the Head of the Department)

12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (about 50 words): To provide advanced level laboratory experiments in telecom signaling and transmission
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14.	Course contents (about 100 words) (Include laboratory/design activities): Specification and implementation of the alternating-bit protocol in SDL ATM-Signaling Protocols Hand-over in GSM radio mobile network, Data transmission with GSM in the non-transparent mode, Protocol analysis of data transmission via Ethernet LAN, Development of voice based services for intelligent networks/NGN, Planning and evaluation of DECT systems, Access network characterization, Network dimensioning and cloud provisioning for NFV in SDN
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15. Lecture Outline (with topics and number of lectures)

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
1	Specification and implementation of protocols using SDL : the alternating-bit protocol	2
2	Characterization of Hand-over	2
3	Data transmission over wireless GSM/CDMA/DECT/ISDN	2

Date:

(Signature of the Head of the Department)

4	Protocol analysis of data transmission – with reference to Ethernet LAN	2
5	Development of voice based services for NGN	2
6	Access network characterization – understanding the L2Media gateway and Session Border Controller	2
7	Network dimensioning and cloud provisioning for NFV in SDN	2

17. Brief description of laboratory activities

Module no.	Description	No. of hours
1	Protocol development using FSM and SDL	4 lab sessions
2	Functional characterization of protocols using protocol analysers	3 lab sessions
3	Protocol tracing and analysis in DOCSIS/V5.2/ISDN-BRI/802.3	3 lab sessions
4	NFV – orchestration controller, vswitch setup and NOX/POX	3 lab sessions

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700/800 level courses)

Module no.	Description	No. of hours
1	Protocols and characterization	14
2	Specification Description Languages	21
3	Access technologies including DOCSIS	21
4	SDN and NFV	28

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year

Lab manual will be made available with specialized handout material

Date:

(Signature of the Head of the Department)

20. Resources required for the course*(itemised & student access requirements, if any)*

20.1	Software	Unix and/or windows, Telelogic Tau, Rhapsody, Rational Rose + Raional Rose-RT and Rational Rose-Embedded
20.2	Hardware	PCs
20.3	Teaching aids (videos, etc.)	Multimedia Projector, Visualizer, lab with NOC projection facilities
20.4	Laboratory	Lab
20.5	Equipment	Protocol analysers for 802.3, V5.2, E1, Bluetooth
20.6	Classroom Infrastructure	One classroom with 50 seats for tutorial ,next to Laboratory
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course (Percent of student time with examples, if possible)

21.1	Design-type problems	30%
21.2	Open-ended problems	10%
21.3	Project-type activity	40%
21.4	Open-ended laboratory work	20%
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Network Software Laboratory
3.	L-T-P structure	0-1-4
4.	Credits	3
5.	Course number	ELP822
6.	Status (<i>category for program</i>)	PE for EEE, EET and Bharti JTM programs

7.	Pre-requisites (course no./title)	ELL818 Telecommunication Technologies OR ELL875 Computer Communication Networks
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	Nil
8.2	Overlap with any UG/PG course of other Dept./Centre	None
8.3	Supersedes any existing course	None

9.	Not allowed for (indicate program names)	Other than Bharti School /EE/CSE students
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10.	Frequency of offering	☐ Every sem ☒ 1st sem ☐ 2nd sem ☐ Either sem -
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11.	Faculty who will teach the course		
	Name	Contact address	email
	1. Dr. Subrat Kar	II-219 EE Dept	subrat@ee.iitd.ac.in
	2. Brejesh Lal		

12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
	<u>Objectives:</u> To introduce the student to practical laboratory assignments with software development specifically for telecom networks	

Date

Signature of the Head of the Department

14.	Course contents (about 100 words) (Include laboratory/design activities): Contents: CASE tools, client-server programming, middleware – and use of Object Request Broker architectures, use of network emulators, using networks APIs Parlay/JAIN, service-oriented architectures, openflow and SDN, network management software design
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

Module no.	Description	No. of hours
1	Software Development Life Cycle in Telecom	1
2	Software CASE Tools and Tool-chains	1
3	Client-server architectures and ORBs, network forensics	3
4	Implementation using network APIs	3
5	Service Oriented Architectures	2
6	Openflow and SDN	2
7	Network Management and OSS Software	2
		14

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1	Software Development Life Cycle in Telecom	10
2	Software CASE Tools and Tool-chains	20
3	Client-server architectures and ORBs, network forensics	10
4	Implementation using network APIs	35

Date

Signature of the Head of the Department

5	Service Oriented Architectures	20
6	Openflow and SDN	40
7	Network Management and OSS Software	10
		140

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

1. A.Fisher, "CASE:Using Software Development Tools", John Wiley, 1991
2. Grady Booch, The UML User Guide, Pearson, 1999

20. Resources required for the course *(itemized & student access requirements, if any)*

20.1	Software	Unix-Ubuntu
20.2	Hardware	Personal Computers (one per student)
20.3	Teaching aides (videos, etc.)	Visualizer, Multimedia Projector
20.4	Laboratory	ONE -
20.5	Equipment	
20.6	Classroom infrastructure	ONE – for tutorials ,required close to Laboratory
20.7	Site visits	
20.8	Others (please specify)	

21. Design content of the course *(Percent of student time with examples, if possible)*

21.1	Design-type problems	
21.2	Open-ended problems	
21.3	Project-type activity	
21.4	Open-ended laboratory work	
21.5	Others (please specify)	

Date

Siganture of the Head of the Department

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL ENGINEERING
2.	Course Title (<i>< 45 characters</i>)	Special Module in Cyber Security
3.	L-T-P structure	1-0-0
4.	Credits	1
5.	Course number	ELV710
6.	Status (<i>category for program</i>)	PE for EEE (M.Tech in Communication Engineering)

7.	Pre-requisites (course no./title)	None
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☐ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course Ranjan Bose
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (about 50 words): To develop an understanding of the principles underlying "cyber security" and acquire the ability to apply those principles in practice, which includes a judicious choice of the tools required to achieve the stated goals.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Overview of cyber security, computer security and the associated threat, attack, adversary models, access control, intrusion detection, basic network security, security of cyber physical systems and a brief introduction to cryptography.
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15. Lecture Outline(with topics and number of lectures)

Module no.	Topic	No. of hours
1.	Introduction to cyber security	2
2.	Definitions/Specifications of "Security" and the associated Threat, attack, adversary models	2
3.	Malicious logic, intrusion detection	2
4.	Basics of Network Security	2
5.	Identity representation, management and access control	2
6.	Security of Cyber Physical Systems	2
7.	Brief introduction to cryptography	2
COURSE TOTAL (14 times 'L')		14

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
	NA	

18. Brief description of module-wise activities pertaining to self-study component
(mandatory for 700 / 800 level courses)

Module no.	Description	No. of hours
1.	Basic cryptography	3
2.	Computer networks	3

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

Matt Bishop, **Computer Security Art and Science**, Addison Wesley

20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	NA
20.2	Hardware	NA
20.3	Teaching aides (videos, etc.)	NA
20.4	Laboratory	NA
20.5	Equipment	NA
20.6	Classroom infrastructure	NA
20.7	Site visits	NA
20.8	Others (please specify)	NA

21. Design content of the course (*Percent of student time with examples, if possible*)

21.1	Design-type problems	NA
21.2	Open-ended problems	NA
21.3	Project-type activity	NA
21.4	Open-ended laboratory work	NA
21.5	Others (please specify)	NA

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Special Module in Communication Systems and Networking-I
3.	L-T-P structure	1-0-0
4.	Credits	1
5.	Course number	ELV720
6.	Status (<i>category for program</i>)	PE for EEE

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Special Module in Communication Systems and Networking-I
3.	L-T-P structure	1-0-0
4.	Credits	1
5.	Course number	ELV821
6.	Status (<i>category for program</i>)	PE for EEE

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Special Module in Communication Systems and Networking-II
3.	L-T-P structure	1-0-0
4.	Credits	1
5.	Course number	ELV821
6.	Status (<i>category for program</i>)	PE for EEE

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course	
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):	
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Special Module in Information Processing - I
3.	L-T-P structure	1-0-0
4.	Credits	1
5.	Course number	ELV823
6.	Status (<i>category for program</i>)	PE for EEE (M. Tech. in Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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11.	Faculty who will teach the course
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12.	Will the course require any visiting faculty? (yes/no)	NO
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13.	Course objectives (<i>about 50 words</i>):
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14.	Course contents (about 100 words) (Include laboratory/design activities):

15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
COURSE TOTAL (14 times 'L')		0

16. Brief description of tutorial activities:

Module	Description	No. of hours

17. Brief description of laboratory activities N/A

Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

19. Suggested texts and reference materials

STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course (*itemized & student access requirements, if any*)

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21. Design content of the course (*Percent of student time with examples, if possible*)

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department /Centre proposing the course	EE
2.	Course Title (<i>< 45 characters</i>)	Special Module in Information Processing - II
3.	L-T-P structure	1-0-0
4.	Credits	1
5.	Course number	ELV823
6.	Status (<i>category for program</i>)	PE for EEE (M. Tech. in Communication Engineering)

7.	Pre-requisites (<i>course no./title</i>)	
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8.	Status vis-à-vis other courses (<i>give course number/title</i>)	
8.1	Overlap with any UG/PG course of the Dept./Centre	NO
8.2	Overlap with any UG/PG course of other Dept./Centre	NO
8.3	Supersedes any existing course	NO

9.	Not allowed for (<i>indicate program names</i>)	Any UG programme
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10.	Frequency of offering	☐ Every sem ☒ 1stsem ☒ 2ndsem ☐ Either sem -
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Module	Description	No. of hours

18. Brief description of module-wise activities pertaining to self-study component (mandatory for 700 / 800 level courses)

Module	Description	No. of hours

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STYLE: Author name and initials, Title, Edition, Publisher, Year.

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20. Resources required for the course *(itemized & student access requirements, if any)*

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21. Design content of the course *(Percent of student time with examples, if possible)*

Date:

(Signature of the Head of the Department)