

New Curriculum for M.Tech. in Power Systems

Overall credit structure

Category	PC	PE	OC	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 770 <i>Power System Analysis</i> (3-0-0)	(PC) ELL771 <i>Advanced Power System Protection</i> (3-0-0)	(PC) ELL775 <i>Power System Dynamics</i> (3-0-0)	(PC) ELP870 <i>Power System Lab1</i> (0-1-4)	PE/OC (3-0-0)	3/4	9/12	1	4	14/17	12/15
II	(PC) ELL776 <i>Advanced Power System Optimization</i> (3-0-0)	(PC) ELP871 <i>Power System Lab 2</i> (0-1-4)	PE/OC (3-0-0)	PE/OC (3-0-0)	PE/OC (3-0-0)	3/2	9/6	1	4	14/11	12/09
SUMMER											
III	(PC) ELD871 <i>Major Project Par-I</i> (0-0-12)		PE / OC (3-0-0)	PE / OC (3-0-0)		2	6	0	12	18	12
IV (Project based)	(PE) ELD871 <i>Major Project Part-II</i> (0-0-24)					0	0	0	24	24	12
IV (Course based)	PE / OC (3-0-0)	PE / OC (3-0-0)	PE / OC (3-0-0)	PE / OC (3-0-0)		4	12	0	0	12	12

Programme Core (PC)

Course Number	Title	L-T-P	Credit
ELD871	Major Project Part-I	0-0-12	6
ELL770	Power System Analysis	3-0-0	3
ELL771	Advanced Power System Protection	3-0-0	3
ELL775	Power System Dynamics	3-0-0	3
ELL776	Advanced Power System Optimization	3-0-0	3
ELP870	Power System Lab 1	0-1-4	3
ELP871	Power System Lab 2	0-1-4	3

Programme Elective (PE)

Course Number	Title	L-T-P	Credit
ELL870	Restructured Power System	3-0-0	3
ELL871	Distribution System Operation and planning	3-0-0	3
ELL872	Selected Topics in Power System	3-0-0	3
ELL773	High Voltage DC Transmission	3-0-0	3
ELL774	Flexible AC Transmission system	3-0-0	3
ELL778	Dynamic Modelling And Control of Sustainable Energy Systems	3-0-0	3
ELD870	Minor Project-I	0-0-6	3
ELL873	Power System Transient	3-0-0	3
ELL874	Power System Reliability	3-0-0	3
ELL779	Forecasting Techniques for Power System	3-0-0	3
ELL772	Planning and operation of Smart grid	3-0-0	3
ELL777	Power System operation and control	3-0-0	3
ELD872	Major Project Part-II	0-0-24	12
ELL759	Power Electronic Converters for Renewable Energy Systems	3-0-0	3
ELL700	Linear Systems Theory	3-0-0	3
ELL758	Power Quality	3-0-0	3
ELL712	Digital Communications	3-0-0	3

COURSE TEMPLATE

1.	Department /Centre proposing the course	Electrical Engineering
2.	Course Title (<i>< 45 characters</i>)	Minor Project (EES)
3.	L-T-P structure	0-0-6
4.	Credits	3
5.	Course number	ELD870
6.	Status (<i>category for program</i>)	M.Tech (PE for EES)

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	
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 Sukumar Mishra, A.R. Abhyankar, N. Senroy, B. K. Panigrahi
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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 do an introductory project in the area of power system.
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14.	Course contents (about 100 words) (Include laboratory/design activities): To be decided by the project supervisor.
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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
	To be decided by the project supervisor.	
		84

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.

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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.)	
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	100%
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>)	Major Project Part I
3.	L-T-P structure	0-0-12
4.	Credits	6
5.	Course number	ELD871
6.	Status (<i>category for program</i>)	M.Tech (PC for EES)

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	
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 Sukumar Mishra, A.R. Abhyankar, N. Senroy, B. K. Panigrahi
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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 do project work in Power Systems area.
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14.	Course contents (about 100 words) (Include laboratory/design activities): To be decided by the project supervisor.
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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
	To be decided by the project supervisor.	
		168

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.

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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.)	
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	100%
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>)	Major Project Part II
3.	L-T-P structure	0-0-24
4.	Credits	12
5.	Course number	ELD872
6.	Status (<i>category for program</i>)	M.Tech (PE for EES)

7.	Pre-requisites (<i>course no./title</i>)	ELD871
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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 Sukumar Mishra, A.R. Abhyankar, N. Senroy, B. K. Panigrahi
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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 do advanced project work in the area of Power system.
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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.

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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.)	
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	100%
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>)	POWER SYSTEM ANALYSIS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	ELL770
6.	Status (<i>category for program</i>)	Programme Core for MTech (EES)

7.	Pre-requisites (course no./title)	ELL 303 FOR BTECH 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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	NA

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☒ 1 st sem ☐ 2 nd sem ☐ Either sem
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11.	Faculty who will teach the course DR. A. R. ABHYANKAR, PROF. P. R. BIJWE, DR. B. K. PANIGRAHI	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): The course is aimed at providing concepts in power system analysis with special focus on analysis of steady state. The student should be able to understand, appreciate and implement the issues in computer aided power system analysis. Alogn with learning some basic aspects of analysis, the student is exposed to higher level intricate issues related to security.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Revision of Basic Concepts in pu and modeling, Admittance model of transmission network, Power Flow solutions (GS, NR, DLF, FDLF, DCLF), Symmetrical components and sequence networks, Faults - Symmetrical and unsymmetrical, Z Bus building algorithms, State Estimation, Voltage Stability, Continuation Power Flow, Power System Security (Overload, Voltage), Introduction to WAMS and PMUs, Linear State Estimation	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction and revision of basic concepts	3
2	Power Flow Solutions	8
3	Symmetrical Components and sequence networks	4
4	Impedance Model	1
5	Z Bus Building algorithm	2
6	Fault Calculation - Symmetrical and Unsymmetrical	6
7	State Estimation	4
8	Voltage Stability	4
9	Power System Security	5
10	Introduction to WAMS, PMU and Linear State Estimation	3
11		
12		
COURSE TOTAL (14 times 'L')		40

16. Brief description of tutorial activities

No tutorials

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	N/A	
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

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|---|
| 1. John Grainger and W. Stevenson, Power System Analysis, TMH
2. Allen Wood, B. Wollenberg, Power Generation, Operation and Control, Wiley |
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19. Resources required for the course *(itemized & student access requirements, if any)*

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Yes

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
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
2.	Course Title (<i>< 45 characters</i>)	Advanced Power System Protection
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL 771
6.	Status (<i>category for program</i>)	PG

7.	Pre-requisites (<i>course no./title</i>)	ELL 400
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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 B K Panigrahi, A R Abhyankar
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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 prime objective of the course to give important operating principle, design and planning of the protective system in a power system. The students will be exposed to traditional electro-mechanical relaying principle as well as to modern numerical relaying basics.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Fundamentals of protection, generator protection, transformer protection, bus bar protection, over current and differential protection. Out of step protection, blinder design. Static relays, Numerical relay. Wide area protection.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Fundamentals of power system protection, Principles of CB, CT, PT. Selection and testing of CBs, transients in CBs	3
2	Principles of relaying: Over current, Directional and Differential. Relay Coordination	4
3	Distance Relays: Principles of Simple Impedance Relay, Reactance relay, MHO relay. Impact of Power swing on performance of distance relays. Power swing Blocking and Out of step protection Design of blinder scheme Effect of line loadability on distance protection	4
4	Transformer, bus bar, transmission line, generator protection schemes and implementation	4
5	Static Relays : Amplitude and Phase Comparators	6
6	Basics of numerical protection	3
7	Numerical protection algorithm: sinusoidal wave based algorithm, Fourier algorithm, Least squares method, Differential equation based techniques, travelling wave based techniques	8
8	Fault location: principle and algorithms	4
9	PMU Design and its algorithm	3
10	Wide area Protection	3
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	CT and CB selection for Substation	3
2	Study of protection coordination between fuse – OCR, OCR - OCR	4
3	Realization of distance relays for long transmission line protection	6
7	Implementation of numerical algorithms for feeder, transformer , transmission line and generator protection	7

19. Suggested texts and reference materials

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

Digital protection for Power System, A T Johns and S K Salman, IEEE Power series
Protection of Electricity Distribution Networks, Juan M Gers and Edward J Holmes, IET
Power and Energy Series
Power System Relaying, Stanley H Horowitz and A G Phadke, Willey

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>)	Planning and operation of Smart grid
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL772
6.	Status (<i>category for program</i>)	PE

7.	Pre-requisites (<i>course no./title</i>)	ELL303
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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	☐ Either sem -
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11.	Faculty who will teach the course N. Senroy, B. K Panigrahi, Sukumar Mishra, A. R. Abhyankar, P.R. Bijwe	
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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 will introduce the key aspects of planning and operation of smart grids. Cross-linking of various inter-disciplinary topics will be discussed in class. These will include policy, control, communication, instrumentation and core power systems.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Smart grids key characteristics, demand side management, load characteristics, hybrid electric vehicles, energy markets, deregulation, wide area monitoring, protection and control, smart metering, adaptive relaying, power line carrier communication and networking, architectures and standards, renewable energy, distributed generation, smart grids policies.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Smart Grids – Key characteristics of Smart Grids, Key functions of smart grid, smart grid elements – physical layer (grid), Control layer, applications layer, various aspects – demand side, transmission side, protection, communication, renewable, policy	5
2	The demand side of electricity - Load characteristics - Load curve and load duration curve - Demand side management - Plug-in hybrid vehicles and smart appliances	5
3	The economics of supply and demand in energy markets - Review of optimization (linear and nonlinear programming) - Modeling the consumers and producers - Market equilibrium - Long-run vs. short-run costs - Energy market deregulation	5
4	Transmission aspects – Wide area Monitoring Systems (WAMS), PMU and PDCs, PMU placement, linear state estimation, System security under smart grid environment, grid reliability and self healing	5
5	Protection aspects of smart grid – adaptive relaying using PMUs, out of step relaying using PMU data	5
6	Communication aspects - Elements of communication and networking: architectures, standards and adaptation of power line communication (PLCC), zigbee, GSM, and more; machine-to-machine communication models for the smart grid; Home area networks (HAN) and neighborhood area networks (NAN); reliability, redundancy and security aspects.	5
7	Renewable energy - Elements of distributed energy resources (DER) and grid integration: renewable energy, energy storage; solar energy, wind energy, biomass, hydropower, geothermal and fuel cell; effect of electric vehicles (EVs).	5
8	Smart Grids policy and regulation	5
9	Case studies	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

19. Suggested texts and reference materials

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

A. Keyhani, "Smart Power Grid Renewable Energy Systems," Wiley 2011
William H. Kersting, Distribution System Modeling and Analysis, CRC Press, Second Edition, 2004
M. A. El-Sharkawi, Electric Energy: An Introduction, CRC Press, 2005

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>)	High Voltage DC Transmission
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL773
6.	Status (<i>category for program</i>)	PE (for EES)

7.	Pre-requisites (<i>course no./title</i>)	N.A
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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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supersedes any existing course	NA

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☐ Either sem - 2nd semester
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11.	Faculty who will teach the course Sukumar Mishra, Nilanjan Senroy, Bijaya K Panigrahi, Bhim Singh
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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>): Introduction to power system optimization problems, importance, and linkages. Understanding solution techniques suitable for specific problems This course will develop an understanding of the control and operation of High Voltage DC Transmission system. The effect of different control modes on the behavior of the power system will be explored.	
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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. HVDC Power Transmission Systems, K.R. Padiyar, New Age International
2. Power System Stability and control, Prabha Kundur, Tata McGraw-Hill

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

20.1	Software	MATLAB
20.2	Hardware	Desktop PCs
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	Solving assignment problems using MATLAB (20 hrs)
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>)	Flexible AC Transmission System
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL774
6.	Status (<i>category for program</i>)	PE for EES

7.	Pre-requisites (<i>course no./title</i>)	N.A
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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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supersedes any existing course	NA

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☐ Either sem - 2nd semester
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11.	Faculty who will teach the course Sukumar Mishra, Nilanjan Senroy, Bijaya K Panigrahi, Bhim Singh
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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>): Introduction to power system optimization problems, importance, and linkages. Understanding solution techniques suitable for specific problems This course will develop an understanding of the control and operation of Flexible AC Transmission system. The effect of different FACTS devices to the operation and control of power system will be presented.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): The phenomenon of voltage collapse; the basic theory of line compensation. Static VAR compensators; static phase shifters; thyristors controlled series capacitors. Co-ordination of FACTS devices with HVDC links. The FACTS optimization problem. Transient and dynamic stability enhancement using FACTS components.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to FACTS	2
2	Voltage Stability and Voltage Collapse	5
3	Line Compensation method	3
4	Static VAR compensators and phase shifters	6
5	Thyristor Controlled Series Capacitors	4
6	Co-ordination of FACTS with HVDC	4
7	Stability Enhancement using FACTS	4
8	STATCOM	4
9	UPFC	4
10	Sub-synchronous Resonance and FACTS devices	6
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

19. Suggested texts and reference materials

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

- 1.UNDERSTANDING FACTS, Narain G. Hingorani, Laszlo Gyugyi, Wiley.
2. FACTS CONTROLLERS IN POWER TRANSMISSION AND DISTRIBUTION, NEW AGE INTERNATIONAL PUBLISHERS

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

20.1	Software	MATLAB
20.2	Hardware	Desktop PCs
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	Solving assignment problems using MATLAB (20 hrs)
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>)	Power System dynamics
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	EEL775
6.	Status (<i>category for program</i>)	Core

7.	Pre-requisites (<i>course no./title</i>)	ELL 303
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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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supersedes any existing course	NA

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☐ Either sem - 2nd semester
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11.	Faculty who will teach the course Sukumar Mishra, N. Senroy
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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>): Introduction to dynamics of synchronous machines, Transient angle Stability, voltage stability, understanding PSS.
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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	Term paper	8
2	Problem solving Assignments	20

19. Suggested texts and reference materials

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

1. Power System Stability and Control, PrabhaKundur, Tata McGraw-Hill

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

20.1	Software	MATLAB
20.2	Hardware	Desktop PCs
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	Solving assignment problems using MATLAB (20 hrs)
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 Power System Optimization
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	EEL776
6.	Status (<i>category for program</i>)	Core

7.	Pre-requisites (<i>course no./title</i>)	ELL 303
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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	ELL 431
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supersedes any existing course	NA

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☐ Either sem - 2nd semester
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11.	Faculty who will teach the course	A.R. Abhyankar, P.R.bijwe
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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>): Introduction to power system optimization problems, importance, and linkages. Understanding solution techniques suitable for specific problems	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Introduction to power system optimization problems and linkages. Optimization basics and solution techniques for convex and non convex optimization problems. Basic Optimal power flow. Preventive and corrective security constrained optimal power flow, Unit commitment, hydrothermal scheduling, generation, transmission and reactive expansion planning. Optimization with uncertain data Introduction to power system optimization problem and their linkages. Security states and optimization requirements. Convex and nonconvex optimization techniques. Static and dynamic optimization techniques. Day ahead and real time market planning. Optimization to handle uncertainty in data. Fuzzy and probabilistic techniques. Generation, transmission and reactive resources planning. Renewable generation integration optimization. Effect of markets and renewable generation in resources planning.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction, linkages, optimization basics	5
2	Economic dispatch	3
3	Introduction to optimization techniques	4
4	Optimal power flow	7
5	Security constrained optimal power flow	5
6	Unit commitment	3
7	Hydrothermal scheduling	3
8	Generation, Transmission, and reactive expansion planning	5
9	Optimization with uncertain data	4
10	Renewable generation integration optimization.	2
11	Effect of markets and renewable generation in resources planning.	1
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
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	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	Term paper	8
2	Problem solving Assignments	20

19. Suggested texts and reference materials

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

1. Powe generation operation and control, Wood and Woolenberg, WSE
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20. Resources required for the course (*itemized & student access requirements, if any*)

20.1	Software	MATLAB
20.2	Hardware	Desktop PCs
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	Solving assignment problems using MATLAB (20 hrs)
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>)	Power System Operation and Control
3.	L-T-P structure	3 – 0 – 0
4.	Credits	3
5.	Course number	ELL777
6.	Status (<i>category for program</i>)	Programme Elective

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 Nilanjan Senroy, Bijaya K Panigrahi, Sukumar Mishra
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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 will develop an understanding of the philosophy behind power system operation and control. Large conventional grids will be the focus, with steam turbines and hydro generators. Mathematical modelling and linearization techniques will be applied.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Control of active power. Turbine, governor and boiler modelling and control. Hydro and steam turbines, load frequency control, Automatic generation control in single-area and multi-area systems. Under-frequency load shedding, secondary frequency control. Automatic voltage regulators, excitation systems – modelling and control, small-signal stability studies, power system stabilizers, on-load tap-changing transformers
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Fundamental electromechanical swing equation	2
2	Turbine modelling – hydro and steam	4
3	Governor modelling	1
4	Load-frequency control	2
5	AGC – single area and multi-area	4
6	Spinning reserves, system frequency characteristics	2
7	Automatic voltage regulators	2
8	Excitation systems	6
9	Power System Stabilizers	5
10	SCADA	2
11	On-load tap changing transformers	4
12	Wide area measurement systems, phasor measurement units	4
13	Case studies	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

19. Suggested texts and reference materials

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

Prabha Kundur, Power System Stability and Control, McGraw Hill
Jan Machowski, Janusz Bialek, Jim Bumby, Power System Dynamics: Stability and Control, 2nd Edition, 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.)	
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>)	DYNAMIC MODELING AND CONTROL OF SUSTAINABLE ENERGY SYSTEMS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	ELL778
6.	Status (<i>category for program</i>)	Programme Elective for EES

7.	Pre-requisites (course no./title)	NIL
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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	ELL 746 (30%)
8.2	Overlap with any UG/PG course of other Dept./Centre	ESL 768 (<10%), ESL740 (<10%)
8.3	Supercedes any existing course	NA

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course Dr. Sukumar Mishra, Dr. Nilanjan Senroy, Prof. Bhim Singh	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): Dynamic modeling and control aspects of distributed generation and sustainable energy technologies will be taught. Course is meant for post graduate students, specifically a departmental elective for M.Tech (EES) students).	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Microgrids and distributed generation; Introduction to renewable energy technologies; electrical systems and generators used in wind energy conversion systems, diesel generators, combined heat cycle plants, inverter based generation, solar PV based systems, fuel cell and aqua-electrolyzer, battery and flywheel based storage system; Voltage and frequency control in a microgrid; Grid connection interface issues	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to distributed generation and microgrids	3
2	Dynamic modeling of electrical systems in distributed generation	3
3	Review of Parks Transform	1
4	Electrical modeling and control of:	
5	Wind turbines and generators	6
6	Diesel generators	4
7	Combined cycle power plant	2
8	Solar PV systems	5
9	Fuel cells and aqua-electrolyzer	5
10	Battery and flywheel energy storage system	5
11	Voltage and frequency control of microgrid	4
12	Grid interface issues	2
COURSE TOTAL (14 times 'L')		40

16. Brief description of tutorial activities

No tutorials

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	N/A	
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

- | |
|---|
| <ul style="list-style-type: none"> i. N. Jenkins, J. B. Ekanayake, G. Strbac "Distributed Generation", 1st, IET London, 2010 ii. S. Chowdhury, S.P. Chowdhury, P. Crossley "Microgrids and Active Distribution Networks", 1st Edition, IET London, 2009 iii. Olimpo Anaya-Lara, Nick Jenkins, Janaka Ekanayake, Phill Cartwright, Michael Hughes "Wind Energy Generation: Modelling and Control", 1st Edition, Wiley, 2009 iv. Munteanu, A. I. Bratcu, N.-A. Cutululis, E. Ceanga "Optimal Control of Wind Energy Systems", 1st Edition, Springer, 2008 |
|---|

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

19.1	Software	
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	LCD
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Yes
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	20%
20.3	Project-type activity	20%
20.4	Open-ended laboratory work	N/A
20.5	Others (please specify)	Simulation exercises using specialized softwares

Date:

(Signature of the Head of the Department)

COURSE TEMPLATE

1.	Department/Centre proposing the course	ELECTRICAL	
2.	Course Title (<i>< 45 characters</i>)	Forecasting Techniques for Power System	
3.	L-T-P structure	3-0-0	
4.	Credits	3	
5.	Course number	ELL779	
6.	Status (<i>category for program</i>)	Programme Elective for EES MTECH	

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)	
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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 B K Panigrahi, A R Abhyankar
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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>): Forecasting is a central and integral process for planning, operations and facility expansion in the power sector. Forecasting of wind power, electric loads and energy price have become a major issue in power systems. The primary objective of this course is to provide an overview of forecasting problems and techniques in power system. Available forecasting techniques will be reviewed with the focus on data mining for load, price and wind speed / power prediction.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Principles of forecasting load, wind and price. Statistical and non statistical based approaches. AI application for forecasting
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15. **Lecture Outline(with topics and number of lectures)**

Module no.	Topic	No. of hours
1	Fundamentals of deregulated power market Market time lines Forecast based decision time frames	2
2	Principles of forecasting, Taxonomy of forecasting techniques, univariate/multivariate forecasting, forecasting performance measurement.	3
3	Statistical forecasting Overview of regression, time series techniques AR, MA, ARMA, ARMAX, ARIMA.	3
4	Artificial Intelligence Techniques: fundamentals, mathematical modeling Neural Networks Fuzzy Neural Networks Support Vector Machines Hybrid Techniques	4
5	Load Forecasting: Key issues and challenges Data selection, analysis and preprocessing Feature selection Modeling Model application and validation	8
6	Price forecasting Key issues and challenges, price spikes and volatility analysis Data selection, analysis and preprocessing Feature selection Modeling Model application and validation	8
7	Wind speed/power forecasting, ramp forecasting Key issues and challenges Data selection, analysis and preprocessing Feature selection Modeling Model application and validation	8
8	Uncertainty quantification of forecasts Confidence/Prediction Intervals	4

9	Future Scope and new challenges in emerging smart grid environment	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
3	MATLAB/R implementation of some basic regression, time series techniques	4
4	Study of Artificial intelligence algorithms, implementation on simple regression/classification problems	4
5	Case studies on load data for different markets and development of forecast models.	6
6	Case studies on electricity price data for different markets and development of forecast models.	6
7	Case studies on wind speed/power data for different markets and development of forecast models.	6

19. Suggested texts and reference materials

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

Mohammed Shahidehpour, Hatim Yamin, Zui Li, *Market Operations in in Electric Power System: forecasting, scheduling and risk mangement*, John Wiley & Sons Ltd, 2002.

Rafal Weron, *Modelling and Forecasting Electricity Loads and Prices: A statistical approach*, John Wiley & Sons Ltd, 2006.

G.P. Box and G.M. Jenkins, *Time Series Analysis: Forecasting and Control*, Holden-Day Inc.

S. Makridakis, S.C. Wheelwright, R.J. Hyndman, *Forecasting Methods and Applications*, Wiley, 1998.

Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, *An Introduction to Statistical Learning with Applications in R*, Springer, 2013.

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

20.1	Software	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>)	RESTRUCTURED POWER SYSTEMS
3.	L-T-P structure	3 - 0 - 0
4.	Credits	3
5.	Course number	ELL870
6.	Status (<i>category for program</i>)	Programme Elective for EES MTECH, DE FOR BTECH

7.	Pre-requisites (course no./title)	ELL 303 FOR BTECH 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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supercedes any existing course	NA

9.	Not allowed for (indicate program names)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1 st sem ☐ 2 nd sem ☒ Either sem
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11.	Faculty who will teach the course DR. A. R. ABHYANKAR, PROF. P. R. BIJWE, DR. B. K. PANIGRAHI	
12.	Will the course require any visiting faculty?	No

13.	Course objective (<i>about 50 words</i>): This course is intended to provide a comprehensive treatment towards understanding of the new dimensions associated with operation of 'restructured' or 'deregulated' power systems.	
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14.	Course contents (<i>about 100 words</i>) (<i>Include laboratory/design activities</i>): Philosophy of market models, Concepts in micro-economics, Centralized and de-centralized Dispatch Philosophies, Congestion Management, Ancillary Service Management, Transmission Pricing Methods, Loss Allocation Algorithms, Locational Marginal Price (LMP) calculation and properties, Financial Transmission Rights (FTRs), Transmission Expansion Planning, Market Power, Working of International Power Markets, Restructuring Issues in Indian Power Sector	
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Introduction to Restructuring of Power Industry	1
2	Fundamentals of Economics	3
3	The Philosophy of Market Models	4
4	Transmission Congestion management	4
5	Locational Marginal Prices (LMP)	3
6	Financial Transmission Rights (FTR)	3
7	Ancillary Service Management	3
8	Transmission Pricing Methods and Loss Allocation Algorithms	5
9	Transmission Expansion Planning Under Restructured Environment	3
10	Market Power and Generator Bidding	3
11	US and European Power Market Evolution	4
12	Reforms in Indian Power Sector	4
COURSE TOTAL (14 times 'L')		40

16. Brief description of tutorial activities

No tutorials

17. Brief description of laboratory activities

Module no.	Experiment description	No. of hours
1	N/A	
2		
3		
4		
5		
6		
7		
8		
9		
10		
COURSE TOTAL (14 times 'P')		

18. Suggested texts and reference materials

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

- | |
|---|
| <ul style="list-style-type: none"> i. A. R. Abhyankar, S. A. Khaparde, NPTEL Web Course: Restructured Power System, Available: http://nptel.iitm.ac.in/courses/108101005/ ii. Fundamentals of Power System economics
Daniel Kirschen and Goran Strbac, John Wiley & Sons Ltd, 2004 iii. Making competition work in electricity
Sally Hunt, John Wiley & Sons, Inc., 2002 iv. Operation of restructured power systems
Kankar Bhattacharya, Jaap E. Daadler, Math H.J Bollen, Kluwer Academic Pub., 2001 |
|---|

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

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

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

20.1	Design-type problems	
20.2	Open-ended problems	
20.3	Project-type activity	
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>)	Distribution System Operation and Planning
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL 871
6.	Status (<i>category for program</i>)	Elective

7.	Pre-requisites (<i>course no./title</i>)	NA
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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	NA

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☐ Either sem - Either Semester
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11.	Faculty who will teach the course A.R. Abhyankar, P.R.Bijwe
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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>): Introduction to the structure of Distribution system. Understanding techniques required for analysis and optimization of the distribution system problems
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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	Term paper	10

19. Suggested texts and reference materials

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

1. T. Gonen, Electric power distribution system engineering, MH,
2. W.H. Kersting, Distribution system modeling and analysis, CRC Press, 2012

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	Assignments on system analysis and optimization
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	Department of Electrical Engineering
2.	Course Title (< 45 characters)	Selected Topics in Power System
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL872
6.	Status (category for program)	MTech (PE for EES)

7.	Pre-requisites (course no./title)	To be decided by Instructor when floating this course
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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)	- NONE -
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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 Sukumar Mishra, A.R. Abhyankar, N. Senroy, B. K. Panigrahi
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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 the emerging new and interesting topics in power system area, over and above the established courses.
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14.	Course contents (about 100 words) (Include laboratory/design activities): To be decided by the Instructor when floating this course: It can be anything that is related to power system, but is not covered in any of the established courses.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
	To be decided by the Instructor	
	COURSE TOTAL <i>(14 times 'L')</i>	42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours
	COURSE TOTAL <i>(14 Hrs)</i>	14

17. Brief description of laboratory activities

Module no.	Description	No. of hours

18. 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.

To be decided and announced by Instructor

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>)	Power System Transients
3.	L-T-P structure	3 – 0 – 0
4.	Credits	3
5.	Course number	ELL873
6.	Status (<i>category for program</i>)	Programme Elective

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	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)	
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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 Nilanjan Senroy, Bijaya K Panigrahi, Sukumar Mishra, Abhijit Abhyankar
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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>): Analyse the nature and origin of electrical transients in power systems. Surges due to lightening and switching operations will be analysed. Substation equipment for protection against electrical transients will also be discussed.
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14.	Course contents (about 100 words) (Include laboratory/design activities): Origin and nature of transients and surges. Lumped and distributed circuit representations. Line energisation and de-energisation transients, current chopping, short-line faults, trapped charge effects, effect of source, control of transients, Lightning, effect of tower footing resistance, travelling waves, insulation coordination, circuit breakers duty, surge arresters, overvoltage limiting devices
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Fundamental concepts of RLC circuit analysis, application of Laplace transform	3
2	Simple switching transients	5
3	Effect of resistance on LC circuit transients	4
4	Abnormal switching transients	4
5	Transients in three-phase circuits	4
6	Travelling waves on transmission lines	5
7	Lightening	5
8	Insulation coordination	4
9	Overvoltage protection, substation equipment	5
10	Case studies	3
COURSE TOTAL (14 times 'L')		42

16. Brief description of tutorial activities:

Module no.	Description	No. of hours

17. Brief description of laboratory activities

[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
1	Assignments	20
2	Self study module	20

19. Suggested texts and reference materials

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

Allan Greenwood, Electrical Transients in Power Systems, Wiley-Blackwell; 2nd Edition edition, 1991
Pritindra Chowdhuri, Electromagnetic Transients in Power Systems (High-Voltage Power Transmission), 2nd edition, PHI Learning

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>)	Power System Reliability
3.	L-T-P structure	3-0-0
4.	Credits	3
5.	Course number	ELL874
6.	Status (<i>category for program</i>)	Elective

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	
8.3	Supersedes any existing course	

9.	Not allowed for (<i>indicate program names</i>)	
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10.	Frequency of offering	☐ Either sem -
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11.	Faculty who will teach the course Sukumar Mishra, Abhijit Abhyankar, Bijaya K Panigrahi, Nilanjan Senroy	
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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 will cover key aspects of power system reliability. Starting from the basic concepts of reliability, indepth discussions on reliability in generation systems, transmission systems and distribution systems will be carried out.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Review of basic probability theory, reliability theory, network modeling and evaluation of simple and complex systems, generation system reliability – concept of loss of load probability, energy not served, transmission system reliability, component failure, distribution system reliability with perfect and imperfect switching.
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15. Lecture Outline *(with topics and number of lectures)*

Module no.	Topic	No. of hours
1	Review of basic probability theory	4
2	Probability distributions	3
3	Application of binomial distribution to engineering problems	3
4	Probability distribution in reliability evaluation	3
5	Network modeling and evaluation of simple and complex systems	4
6	Frequency and duration techniques	4
7	System reliability evaluation using probability distributions	3
8	Generation system reliability evaluation	3
9	Concept of loss of load probability, energy not served	4
10	Transmission system reliability – isolated systems	5
11	Radial distribution system reliability – perfect and imperfect switching	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

[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

19. Suggested texts and reference materials

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

Roy Billington, Robert J. Ringlee, Allen J. Wood, Power System Reliability Calculations, MIT Press, 1973.

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>)	POWER SYSTEM LAB I
3.	L-T-P structure	0-1-4
4.	Credits	3
5.	Course number	ELP870
6.	Status (<i>category for program</i>)	CORE

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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supersedes any existing course	NA

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☐ Either sem - 1st Sem
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11.	Faculty who will teach the course	A.R. Abhyankar, P.R.Bijwe
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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>): Introduction to MATLAB and PSA packages. Becoming familiar with detailed solutions with the packages different power system studies. Understanding power system behaviour through extensive simulation studies	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Power flow studies, fault studies, state estimation, security analysis, robust power flow methods, power flow with uncertain data
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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
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
1	Power Flow studies using NRLF and FDLF	8
2	Balanced and unbalanced Fault studies	8
3	State estimation	4
4	Overload and voltage security analysis	8
5	Continuation power flow, Optimal multiplier based non divergent power flow	8
6	Fuzzy and probabilistic power flow	8
	1 hour discussion on each lab day	

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	MATLAB practice	8
2	Additional system studies for every exercise	20

19. Suggested texts and reference materials

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

1. Power System Analysis by Grainger and Stevenson, TMH
2. Power Generation operation and control, Wood and Wollenberg, WSE

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

20.1	Software	MATLAB
20.2	Hardware	Desktop PCs
20.3	Teaching aides (videos, etc.)	Yes
20.4	Laboratory	Simulation Lab
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	Using professional PSSE software for system studies
21.4	Open-ended laboratory work	Extra system studies
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>)	POWER SYSTEM LAB 2
3.	L-T-P structure	0-1-4
4.	Credits	3
5.	Course number	ELP871
6.	Status (<i>category for program</i>)	CORE

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	NA
8.2	Overlap with any UG/PG course of other Dept./Centre	NA
8.3	Supersedes any existing course	NA

9.	Not allowed for (<i>indicate program names</i>)	NA
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10.	Frequency of offering	☐ Every sem ☐ 1stsem ☐ 2ndsem ☐ Either sem - 1st Sem
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11.	Faculty who will teach the course	Sukumar Mishra, N. Senroy
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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>): Introduction to Dynamics based simulation using MATLAB/SIMULINK, DigSilent, PSS^E, etc. Becoming familiar with detailed solutions with the packages different power system dynamic studies. Understanding power system behaviour through extensive simulation studies.	
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14.	Course contents (about 100 words) (Include laboratory/design activities): Power flow studies, fault studies, state estimation, security analysis, robust power flow methods, power flow with uncertain data
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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
	NA	

17. Brief description of laboratory activities

Module no.	Description	No. of hours
1	Dynamic studies of Single Machine Infinite Bus with AVR, PSS	8
2	Load Frequency Control and Automatic Generation Control	8
3	Eigen value and Participation Matrix	4
4	PSS Tuning in multi machine scenario	8
5	Wide area control for dynamic stability improvement	8
6	Real Time Simulation and HIL	8
	1 hour discussion on each lab day	

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. Power System Stability and Control, P. Kundur, TMH

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

20.1	Software	MATLAB, DigSilent, PSS ^E , Opal RT
20.2	Hardware	Desktop PCs
20.3	Teaching aides (videos, etc.)	Yes
20.4	Laboratory	Simulation Lab
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	Using professional DigSilent, PSSE software for system studies
21.4	Open-ended laboratory work	Extra system studies
21.5	Others (please specify)	

Date:

(Signature of the Head of the Department)