Revised Curriculum

MTech. in Power Electronics, Electrical Machines and Drives (EEP)

Overall credit structure

Category	PC	PE	OC	Total
Credits	24	18	6	48

Semester-wise Distribution of Credits

Sem.	Courses					Lecture Courses	Contact hours/week*				Credits
							L	T	P	Total	
I	(PC) ELL750 Modelling of Electrical Machines **(3-0-0)**	(PC) ELL751 Power Electronic Converters **(3-0-0)**	(PC) ELP850 *Electrical Machines Laboratory* **(0-0-3)**	(PC) ELP851 *Power Electronics Laboratory* **(0-0-3)**	(PE/OE) (3-0-0)*	3	9	0	6	15	12
II	(PC) ELL752 Electric Drive System **(3-0-0)**	(PC) ELL850 Digital Control of Power Electronics and Drive Systems **(3-0-0)**	(PC) ELP852 *Electrical Drives Laboratory* **(0-0-3)**	(PC) ELP853 *DSP Based Control of Power Electronics and Drives Laboratory* **(0-0-3)**	(PE/OE) (3-0-0)*	3	9	0	6	15	12
Project Based											
III	(PC) ELD851 *Major Project Part 1* **(0-0-12)**	PE / OE **(3-0-0)***	PE / OE **(3-0-0)***			2	6	0	12	18	12
IV	(PE) ELD852 *Major Project Part 2* **(0-0-24)**					0	0	0	24	24	12
Course Based											
III	***PE/OE (3-0-0)****	***PE/OE (3-0-0)****	***PE (3-0-0)****	***PE (3-0-0)****		***4***	***12***	***0***	***0***	***12***	***12***
IV	***(PC) ELD851 Major Project Part 1 (0-0-12)***	***PE/OE (3-0-0)****	***PE/OE (3-0-0)****			***2***	***6***	***0***	***12***	***18***	***12***

*** Tentative, depends on the PE/OE course structure**

List of Programme Core:

Sl. No.	Course No.	Course Title	L-T-P-	Credits
1	ELD851	Major Project Part-I	0-0-12	6
2	ELD852*	Major Project Part-II*	0-0-24	12*
3	ELL750	Modelling of Electrical Machines	3-0-0	3
4	ELL751	Power Electronic Converters	3-0-0	3
5	ELL752	Electric Drive System	3-0-0	3
6	ELL850	Digital Control of Power Electronics and Drive Systems	3-0-0	3
7	ELP850	Electrical Machines Laboratory	0-0-3	1.5
8	ELP851	Power Electronics Laboratory	0-0-3	1.5
9	ELP852	Electrical Drives Laboratory	0-0-3	1.5
10	ELP853	DSP Based Control of Power Electronics and Drives Laboratory	0-0-3	1.5

* ELD852 Major Project Part-II is PC only for “Project Based” MTech programme.

List of Programme Electives:

Sl. No.	Course No.	Course Title	L-T-P-	Credits
1	ELD850	Minor Project	0-0-6	3
2	ELL700	Linear Systems Theory	3-0-0	3
3	ELL703	Optimal Control Theory	3-0-0	3
4	ELL704	Robotics and Automation	3-0-0	3
5	ELL706	Digital Control	3-0-0	3
6	ELL720	Digital Signal Processing - I	3-0-2	4
7	ELL753	Physical Phenomena in Electrical Machines	3-0-0	3
8	ELL754	Permanent Magnet Machines	3-0-0	3
9	ELL755	Variable Reluctance Machines	3-0-0	3
10	ELL756	Special Electrical Machines	3-0-0	3
11	ELL757	Energy Efficient Motors	3-0-0	3
12	ELL758	Power Quality	3-0-0	3
13	ELL759	Power Electronic Converters for Renewable Energy Systems	3-0-0	3
14	ELL760	Switched Mode Power Conversion	3-0-0	3
15	ELL761	Power Electronics for Utility Interface	3-0-0	3
16	ELL762	Intelligent Motor Controllers	3-0-0	3
17	ELL763	Advanced Electric Drives	3-0-0	3
18	ELL764	Electric Vehicles	3-0-0	3
19	ELL765	Smart Grid Technology	3-0-0	3
20	ELL766	Appliance Systems	3-0-0	3
21	ELL767	Mechatronics	3-0-0	3
22	ELL768	Computer Aided Design of Power Electronic Systems	3-0-0	3
23	ELL787	Embedded Systems and Applications	3-0-0	3
24	ELL797	Neural Systems	3-0-0	3
25	ELL851	Computer Aided Design of Electrical Machines	3-0-0	3
26	ELL852	Condition Monitoring of Electrical Machines	3-0-0	3
27	ELL853	Advanced Topics in Electrical Machines	3-0-0	3
28	ELL854	Selected Topics in Electrical Machines	3-0-0	3

29	ELL855	High Power Converters	3-0-0	3
30	ELL856	Advanced Topics in Power Electronics	3-0-0	3
31	ELL857	Selected Topics in Power Electronics	3-0-0	3
32	ELL858	Advanced Topics in Electric Drives	3-0-0	3
33	ELL859	Selected Topics in Electric Drives	3-0-0	3
34	ELP854	Electrical Machines CAD Laboratory	0-1-4	3
35	ELP855	Smart Grids Laboratory	0-1-4	3
36	ELT850	Industrial Training and Seminar	0-0-6	3

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	**Modeling of Electrical Machines**
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL750
6.	**Status** (*category* for *program*)	PC for M.Tech(EEP), UG Stream Elective

7.	**Pre-requisites** (course no./title)	ELL 203 for UG

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)	

10.	**Frequency of offering**	☐Every sem☒1stsem☐2ndsem☐Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R.Rajagopal, Prof.G. Bhuvaneswari, Prof. M. Veerachary, Dr. Amit Kumar Jain, Dr.Ramkrishan Maheswari, Dr. Anandarup Das

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** To introduce the concepts involved in the modeling of transformer, DC as well as AC electric machines.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Review of dynamic Modeling of systems,Basic concepts of electromechanical energy conversion, Modeling of Transformer, Generalized Theory of Electrical machines, Modeling of DC Machine, Induction Machine, Wound Field Synchronous machine, and special machines such as BLDC, PMSM etc,.

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

Module no.	Topic	No. of hours
1	Basic concepts of electromechanical energy conversion	2
2	Review of modeling of electromechanical systems	4
3	Generalized theory of electrical machines	7
4	Modeling of DC Machine	4
5	Modeling of Induction Machine	6
6	Modeling of synchronous machine	5
7	Modeling of brushless dc machine	3
8	Modeling of permanent magnet synchronous machine	4
9	Modeling of special machines	4
10	Modeling of transformer	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

19. Suggested texts and reference materials

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

1.P.C. Krause, O. Wasynczuk, and S.D. Sudhoff, *Analysis of Electric Machinery and Drive Systems,* IEEE Press, 2nd ed. 2002

2.C. V. Johns,*Unified Theory of Electrical Machines,* Butterworth, London, 1967

3.C. Ong, *Dynamic Simulation of Electric Machinery,* Prentice Hall, 1997.

4. Ramu Krishnan, “Permanent Magnet and BLDC Motor Drives”, CRC Press.

5. T. J. E. Miller, Brushless Permanent-Magnet and Reluctance Motor Drives

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	30%
21.2	Open-ended problems	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0%
21.5	Others (please specify)	0%

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**ELCTRICAL ENGINEERING**
2.	**Course Title** *(< 45 characters)*	POWER ELECTRONIC CONVERTERS
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	**ELL751**
6.	**Status** (*category* for *program*)	PC

7.	**Pre-requisites** (course no./title)	Not Applicable

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	Not Applicable

10.	**Frequency of offering**	☐Every sem☒1stsem☐2ndsem☐Either sem -

11.	**Faculty who will teach the course** Prof. M. Veerachary, Dr. Amit Kumar jain, Dr. R. K. Maheshwari, Dr. Anandarup Das, Prof.K.R.Rajagopal, Prof. Bhim Singh, Prof. G. Bhuvaneshwari

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** To expose the students to various types of power electronic devices and converter circuits including brief analysis and design concepts.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Introduction to various power switching devices and their control, introducing various power electronic circuits for realization of AC-DC, AC-AC, DC-AC, DC-DC conversion, principle of operation, and analysis, pulse-width modulation and pulse frequency control of power electronic converters, design problems on power electronic converter systems.

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

Module no.	Topic	No. of hours
1	Review of power semiconductor switching devices, Thyristors, MOSFET, IGBT,and modern devices, characteristics and applications	2
2	Introduction to Turn-ON/Turn-OFF mechanism of switching devices, Gate-drive circuits, Switching-aid circuits,protection, Heat sink design	4
3	Line-commutated rectifiers, single and three-phase rectifiers (controlled/uncontrolled), performance analysis,harmonics, Ripple reduction techniques, Introduction to multi-pulse converters	8
4	Switch-mode DC-DC Converters, pulse width modulation, Non-isolated and isolated Topologies, continuous and discontinuous modes of operations, steady-state analysis, energy storage elements design, higher-order topologies.	10
5	Inverters, single and three-phase inverter configurations, voltage and current source inverters and their operating modes, voltage control in inverters and harmonic reduction using PWM strategies, Introduction to Multi-level Inverters, applications.	10
6	AC-AC voltage controllers, configurations, performance analysis, harmonics, Cyclo-converters, introduction to Matrix converters and their applications.	8
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
	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
	Learning of new power electronic devices, characteristics and switching mechanism	6
	Learning of PWM rectifiers and control strategies and their application to Inverter, UPS, etc,.	6
	Learning of PWM techniques in DC-DC conversion, new circuit topologies, steady-state analysis methods and their design aspects, and their application to Inverter, UPS, etc,.	6
	Learning of PWM techniques in DC-AC conversion, new inverter circuit topologies, steady-state analysis methods and their design aspects, and their application to Advanced Inverters, UPS, etc,.	6
	Learning of AC-AC conversion systems and their control schemes, new circuit configurations, steady-state analysis methods and their design aspects, and their application to Advanced drives and motion control, etc,.	6

19. Suggested texts and reference materials

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

1. Fundamental of Power Electronics: Robert Erickson, D. Maksimovic
2. Power Electronics, Circuits, Devices and Applications: Muhammad H. Rashid
3. Power Electronic, Devices, Applications, and Passive Components: Barry W. Williams
4. Power Electronics - converters, Applications, and Design: Ned Mohan, Tore. M. Undeland, William P. Robbins

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

20.1	Software	Existing facilities in terms of software are sufficient
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	30%
21.2	Open-ended problems	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0%
21.5	Others (please specify)	0%

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Electric Drive System**
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	**ELL752**
6.	**Status** (*category* for *program*)	PC

7.	**Pre-requisites** (course no./title)	ELL750

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☐1stsem☒2ndsem☐Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K Rajagopal ,Prof. M Veerachary, Prof. G. Bhuvaneswari, Dr. Amit Jain, Dr. Ramkrishan Maheshwari, Dr. Anandarup Das

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** • Understand the concepts and basic operation of electric drive system • Understand closed loop operation of dc, induction and synchronous machine drives • Understand the design techniques of drive system

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Components of electric drive system- electrical machines, power converters and control system. Different types of loads encountered in modern drive applications. dynamics of drive systems, starting, braking, speed-control, steady-state and dynamic operation of motors, load variations, closed loop control of drives, phase controlled and chopper controlled dc drives, induction motor drives,synchronous motor drives, space phasor model, v/f control, direct and indirect vector control, direct torque control, PMSM drives, BLDC drive, drive controller design.

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

Module no.	Topic	No. of hours
1	Review of electric drive system, electrical machines, power converters and control system	1
2	Different types of loads encountered in modern drive applications	2
3	Dynamics of drive systems, starting, braking, speed-control.	3
4	Closed loop dc motor drives – phase controlled and chopper controlled dc drives, controller design.	8
5	Closed loop induction motor drives – Review of dynamic modelling of induction machine, space phasor model.	2
6	Closed loop induction motor drives – V/f control, need for vector control	2
7	Closed loop induction motor drives – direct and indirect vector control, design of controller	8
8	Direct torque control of induction motor drives	3
9	Closed loop synchronous motor drives – Review of dynamic modelling of synchronous machine	2
10	Closed loop synchronous motor drives	5
11	Closed-loop BLDC Drive	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

19. Suggested texts and reference materials

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

1. Werner Leonhard, Control of Electrical Drives, 3rd edition, Springer 2001.
2. R. Krishnan, Electric Motor Drives: Modeling, Analysis, and Control, Prentice Hall, edition 1, 2001.
3. Peter Vas, Sensorless Vector and Direct Torque Control, Oxford, 1998.
4. Bimal K Bose, Modern Power Electronics and AC Drives, Prentice Hall, edition 1, 2001.
5. Recent journal and conference papers.

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	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	30
21.2	Open-ended problems	35
21.3	Project-type activity	35
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	Physical Phenomena in Electrical Machines
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL753
6.	**Status** (*category* for *program*)	PE+UG

7.	**Pre-requisites** (course no./title)	ELL203 for UG

8.	**Status vis-à-vis other courses***(give course number/title)*	
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	Supercedes any existing course	No

9.	**Not allowed for** (indicate program names)	NA

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K .R. Rajagopal, Prof. G. Bhuvaneswari, Dr. Amit kumar Jain, Prof. M. Veerachary, Dr. Anandarup Das, Dr. Ramkrishnan Maheshwari	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** To familiarize the students with various physical phenomena in electrical machines. The students will learn about saturation, eddy current, hysteresis, harmonics, noise and vibration and many other phenomena which are associated with the electrical machines which are to be considered during modeling and detailed analysis of the machines.

14.	**Course contents** *(about 100 words)* Engineering and physical aspects of rotating machines. Modern machine windings. Winding analysis and mmf waveforms. Space and time harmonics. Saturation. Unbalanced magnetic pull and magnetic noise in industrial machines. Heating/Cooling. Unbalanced and asymmetrical operation of induction motors. Special phenomena in electrical machines such as capacitor self excitation of induction machines and its applications. Use of electromagnetic field theory, performance of permanent magnet machines. Magnetic levitation Superconductors and applications. Permanent magnet and Switched Reluctance Motors.

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

Module no.	Topic	No. of hours
1	Introduction to various physical phenomena in electrical machines and comparison between the unified theory of electrical machines and the classical or conventional theories.	2
2	Physical phenomena: saturation, inrush current hysteresis and eddy currents. Harmonics in electrical machines: space harmonic and time harmonic.	2
3	Space harmonic: phase belt harmonic and slot harmonics or tooth ripples. Permeance variation due to slot harmonics, MMF harmonics(variation due to winding distribution). Effects of space harmonics: asynchronous crawling, cogging and synchronous crawling, magnetic noise and vibration, voltage ripples, unbalanced magnetic pull. Methods to suppress space harmonics: skewing and fractional slot winding.	6
3	Leakage reactance: primary slot leakage, secondary slot leakage, zigzag leakage reactance, phase belt leakage reactance, coil and overhang leakage, peripheral leakage and incremental leakage. Air gap permeance wave, stand still locking	2
4	Parasitic magnetic pull: major and minor cause, effects: elastic deformation parasitic torque and noise and vibration. Subharmonics: causes and effectsof unbalance magnetic pull and method to mitigate.	4
5	Stray load losses: origin and other factors on which it depends. Methods to mitigate. Induced voltage ripples, selection of rotor and winding of stator to curtain this effect. Parasitic torque: cause, effect and method to mitigate.	4
6	Unbalanced and asymmetrical operation of three phase induction motor, rotor unbalance, stator unbalance, physical phenomena associated with starting of synchronous motor, slip measurement, beat frequency, George's phenomena.	5
7	Noise and vibration: different standards, types of noise, perception of noise, effect.	5

8	Factors on which noise and vibrations depends, major consideration while designing a quiet motor	3
9	Dynamics of synchronous machines: pull in phenomena, oscillation, asynchronous operation. Factors on which synchronization depends. Forced oscillation and free oscillation. Hunting in synchronous machines.	4
10	Dynamic behavior of dc machines: speed adjustment and shunt field control. Unbalance operation of three phase induction motor.	2
11	Switching and re switching transients, effect of remnant flux, voltage surge, condition of reclosure. Noise level in Switch reluctance motor and other physical phenomena and their effect which are associated with this motor.	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

19. Suggested texts and reference materials

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

[1] Charles V. Jones, “The unified theory of electrical machines”, 1st edition, Butterworths, London, 1967.

[2] Philip L.Alger, “Induction machines their behavior and uses”, 2nd Edition, Gordon and breach science publishers, New York, 1965.

[3] Ion Boldea and S. A. Nasar, “The Induction machine handbook,” CRC Press, 2002.

[4] Bedrich Heller andVaclav Hamata “Harmonic field effects in induction machines” Elsevier academic press, 1977.

[5] P.L. Timar “Noise and Vibration of Electrical Machines” Elsevier Science Ltd,1989.

[6] Martin J. Heathcote and CEng FIEE “The J & P Transformer Book”, 13th edition, Elsevier Ltd, 2007.

[7] R. Belmans, A. Vandenput and W. Geysen“Vibrations and Audible Noise in Alternating Current Machines” Springer Netherlands, 1988.

[8] Jacek F. Gieras, Chong Wang and Joseph Cho Lai “Noise of Polyphase Electric Motors” CRC press, 2006.

[9] R.E.Doherty, O.E.Shirley, “Reactance of synchronous machines and its applications,”*American Institute of Electrical Engineers, Proceedings of the* , vol.37, no.7, pp.821,908, July 1918.

[10] P.J.Tavner, “Cross-magnetisationeffects in electrical machines,”*IEE Proceedings Electric Power Applications,*vol.151, no.3, pp.249-259, 8 May 2004.

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	NO
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	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/~~Centre~~ proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	Permanent Magnet Machines
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	**ELL754**
6.	**Status** (*category* for *program*)	PE + UG

7.	**Pre-requisites** (course no./title)	ELL203 for UG

8.	**Status vis-à-vis other courses***(give course number/title)*	
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	Supercedes any existing course	No

9.	**Not allowed for** (indicate program names)	

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R. Rajagopal, Prof. G. Bhuvaneswari, Dr. Amit kumar Jain, Dr. Anandarup Das, Dr. Ramkrishnan Maheshwari, Prof M Veerachary	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** The main objective of the course is to enhance the knowledge of the students in the field of permanent magnet machines including their design, construction, operating principle; controls and miscellaneous applications. Contents of the course are such that the study facilitates the job of the students in real field.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** Introduction to Permanent Magnet Machines, Permanent Magnet DC Commutator Machines, Permanent Magnet Synchronous Machines, Permanent Magnet Brushless DC machines, Hysteresis motors, Stepper Motors. Moreover various applications of permanent magnet machines are also integral part of syllabus. Various upcoming applications in field of robotics, solar pumping, wind energy generation system and many more are covered in the syllabus. Computer aided simulation studies for modeling and performance analysis are also part of this course.

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

Module no.	Topic	No. of hours
1	Introduction to Permanent Magnet Machines	3
2	Permanent Magnet DC Commutator Machines	6
3	Permanent Magnet Synchronous Machines	6
4	Permanent Magnet Brushless DC machines	6
5	Hysteresis Motors	6
6	Stepper Motors	6
7	Applications in Robotics, Industry Automation, Electric Vehicles, Aerospace, Renewable Energy Generation and Defense Systems, etc.,	3
8	Other Advanced machines	3
9	Computer Aided Simulation of Electrical Machines.	3
COURSE TOTAL *(14 times 'L')*		42

16. Brief description of tutorial activities

Tutorial consists of the exercises of numerical problems and practice of the simulations related to the design, construction, operation of machines and its drives using the software such asMATLAB/PSIM/PSPICE-ORCAD. Tutorial activities will be made more interactive by assignments and evaluations of relevant exercises.

17. Brief description of laboratory activities

Module No.	Experiment description
COURSE TOTAL *(14 times 'P')*	

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 Permanent Magnet Machines	6
2	Permanent Magnet DC Commutator Machines	12
3	Permanent Magnet Synchronous Machines	12
4	Permanent Magnet Brushless DC machines	12
5	Hysteresis Motors	12
6	Stepper Motors	12
7	Applications in Robotics, Industry Automation, Electric Vehicles, Aerospace, Renewable Energy Generation and Defense	6
8	Other Advanced machines	6
9	Computer Aided Simulation of Electrical Machines.	6

19. Suggested texts and reference materials

- **Permanent Magnet DC Commutator Machines**

[1] Bhag S. Guru and H.R. Hiziroglu, "Electrical Machinery and Transformers," 3rd Ed., Oxford University Press, New York, 2001.

[2] Arthur Eugene Fitzgerald, Charles Kingsley, Stephen D. Umans "*Electrical Machinery*" Tata McGraw-Hill publishing Company Limited, New Delhi, India, 2009.

[3] William H. Yeadon, P.E. and Alan W. Yeadon, P.E., "Handbook of Small Electric Motors," McGraw-Hill, 2001.

[4] H.C. Gerhard Henneberger, "Electrical Machines I: Basics, Design, Function, Operation, 2003.

[5] Jacek F. Gieras, "Permanent Magnet Motor Technology: Design and Application," 3rd Ed., CRC press, New York, 2010.

[6] Ion Boldea and S.A.Nasar, "Electric Drives," 2nd Ed., CRC Press, 2005.

- **Permanent Magnet Synchronous Machines**

[7] Bimal K. Bose, *Modern Power Electronics and AC Drives,* New Jersey: Prentice Hall PTR, 2002.

[8] Bhim Singh, B.P. Singh and S. Dwivedi, "A State of Art on Different Configuration of Permanent Magnet Brushless Machines,"IE(I) Journal - EL, vol. 87, pp. 63-68, June 2006.

[9] D.W. Novotny and T.A. Lipo, "Vector Control and Dynamics of AC Drives," Oxford University Press, New York, 1997.

[10] P. Vas, "Sensorless Vector and Direct Torque Control," Oxford University Press, 1998.

[11] R. Krishnan, "Electric Motor drives: Modeling, analysis and control," Pearson education India, 2003.

- **PMBLDC Machines**

[12] J. R. Ireland, "*Ceramic Permanent-Magnet Design and Applications*," McGraw-Hill, New York, 1968.

[13] T. Kenjo and S. Nagamori, "*Permanent-Magnet and Brush less DC Motors*', Clarendon Press, Oxford, 1985.

[14] T. J. E. Miller, "*Brushless Permanent-Magnet and Reluctance Motor Drives*," Clarendon Press, Oxford, 1989.

[15] Y. Dote, "*Servomotor and Motion Control Using digital Signal Processors*," Texas Instruments, New Jersey, 1990.

[16] Y. Dote and S. Kinoshita, "*Brushless Servomotors Fundamentals and Applications*," Clarendon Press, Oxford, 1990.

[17] T. J. Sakira and W. Jaffe, "*Brushless DC Motors, Electronic Commutation and Controls*," Tab Books, 1990, USA.

[18] J. R. Hendershot and T. J. E. Miller, "*Design of Brush less Permanent –*

Magnet Motors," Clarendon Press, 1994, Oxford.
[19] D. C. Hanselman, "*Brushless Permanent-Magnet Motor Design*," McGraw-Hill, 1994.
[20] J. F. Gieras and M. Wing, "*Permanent Magnet Motor Technology*," Marcel Decker, Inc., New York, 1997.

- **Stepper Motors**

[21] B. C. Kuo, "*Theory and Application of Step Motors*," West Publishing Co., St. Paul, USA, 1974.
[22] P. P. Acarnley, "*Stepping Motors: a guide to modern theory and practice*," Peter Peregrinus Ltd., IEE, UK, 1982.
[23] T. Kenjo, "*Stepping Motor and Microprocessor Controls*," Clarendon Press, Oxford, 1984.
[24] A. C. Leenhouts, "*The Art and Practice of Step Motor Control*," Intertech Communication Inc, Ventura (USA), 1987.
[25] V. Athani, "*Stepper Motors, Fundamental, Applications & Design*," New Edge International (P) Ltd., New Delhi, 1997.

- **Hysteresis Motors**

[26] J. J. Nitao, E. T. Scharlemann and B. A. Kirkendall, Equivalent Circuit Modeling of Hysteresis Motors, LLNL, 21 July 2009.
[27] M. A. Mannan, Hysteresis Motor. Available [online]: http://aiubleaders.weebly.com/uploads/1/2/3/3/12339011/05-hysteresis-motors.pdf
[28] M. Azizur Rahman and Ruifeng Qin, "A Permanent Magnet Hysteresis Hybrid Synchronous Motor for Electric Vehicles," IEEE Transactions on Industrial Electronics, vol. 44, no. 1, February 1997.

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

19.1	Software	MATLAB/PSIM/PSPICE-ORCAD/Caspoc
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Classroom with the facility of projector, mike and

		sound system
19.7	Site visits	

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

20.1	Design-type problems	40%
20.2	Open-ended problems	30%
20.3	Project-type activity	
20.4	Open-ended laboratory work	
20.5	Simulation based problems	30%

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department proposing the course**	Electrical Engineering
2.	**Course Title (< 45 characters)**	Energy Efficient Motors
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL757
6.	**Status (category for program)**	PE+UG

7.	**Pre-requisites (course no./title)**	NA

8.	**Status vis-à-vis other courses (give course number/title)**	
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

10.	Frequency of offering	☐Every sem☐1stsem☐2ndsem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R. Rajagopal, Prof. G. Bhuvaneswari, Dr. Amit Kumar Jain, Prof. M. Veerachary, Dr. Ramkrishnan Maheshwari, Dr. Anandarup Das,

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

13.	**Course objectives (about 50 words):** The objective of the course is to familiarize students with concept of energy efficient systems in field of electric motors. Fundamentals and standards related to energy efficient motors are included as a subpart of this course. Case studies considering conventional and advanced motors are also included in the curriculum.

14.	**Course contents** *(about 100 words)* Introduction to energy efficiency and its impacts on social life. Energy-efficient motors, fundamentals of electric motor drives, power factor under non sinusoidal conditions, energy efficient induction motor under different input parameters and applications, adjustable-speed drives their advantages and benefits from efficiency point of view, case studies related to induction motor variable seed drive system, brushless dc motor drive, switched reluctance motor drives, permanent magnet synchronous motor drive etc.

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

Module no.	Topic	No. of hours
1	Introduction : Energy efficiency and its impacts on social life	2
2	Energy-Efficient Motors	
	Standard Motor Efficiencies for various motors	1
	Why More Efficient Motors?, What Is Efficiency?	1
	What Is an Energy-Efficient Motor?, Efficiency Determination	1
	Motor Efficiency Labeling, NEMA Energy-Efficient Motor Standards	1
3	Fundamentals of Electric Motor Drives	
	Power electronic devices, electric motor drives, controlled rectifier, phase controlled AC controller	2
	DC motor control using DC-DC converter	1
4	Power Factor and its definition under various practical conditions	
	Power Factor and its definition for ideal sinusoidal system.	1
	Improvement of factor : Reasons and methods	1
	The Power Factor with Nonlinear Loads, Harmonics and the Power Factor, Power Factor Motor Controllers	2
5	Energy efficient induction motor under different input parameters and applications	
	Varying Duty Applications,	1
	Voltage Unbalance ,Voltage Variation	2
	Poly-phase Induction Motors Supplied by Adjustable-Frequency Power Supplies	2
6	Adjustable-Speed Drives their Advantages and Benefits from Efficiency Point of View	
	The Impact of Motor Efficiency, Advantages of Variable-Speed Motors	2
	Adjustable-Speed Drive Applications	2
7	Induction Motor Variable Seed Drive System a Case Study	5
8	Brushless DC motor Drive a Case Study	5
9	Switched Reluctance Motor Drives a Case Study	5

10	Permanent Magnet Synchronous Motor Drive a Case Study	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
1	Introduction : Energy efficiency and its impacts on social life	2
2	Energy-Efficient Motors	4
3	Fundamentals of Electric Motor Drives	4
4	Power Factor and its definition under various practical conditions	6
5	Energy efficient induction motor under different input parameters and applications	6
6	Adjustable-Speed Drives their Advantages and Benefits from Efficiency Point of View	4
7	Induction Motor Variable Seed Drive System a Case Study	8
8	Brushless DC motor Drive a Case Study	8
9	Switched Reluctance Motor Drives a Case Study	8
10	Permanent Magnet Synchronous Motor Drive a Case Study	8

19. **Suggested texts and reference materials**

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

[1] Ali Emadi "Energy efficient electric motors" 3rd Edition, revised and expanded, Marcel Dekker, 2005.

[2] John C. Andreas "Energy-Efficient Electric Motors Selection and Application" Marcel

Dekker, 1982.
[3] Wei Tong “Mechanical Design of Electric Motors” CRC Press, 2014.
[4] B.N. Chaudhari and B.G. Fernandes, “Permanent magnet synchronous motor for general purpose energy efficient drive,”*IEEE Power Engineering Society Winter Meeting*, 2000, vol.1, pp.213-218.
[5] P. Pillay, “Practical considerations in applying energy efficient motors in the petrochemical industry,” *42nd AnnualPetroleum and Chemical Industry Conference Industry Applications Society, 1995,* pp.197-207.
[6] A. H. Bonnett, “Quality and reliability of energy efficient motors,”*IEEE Industry Applications Magazine,* vol.3, no.1, pp.22-31, 1997.
[7] Kao Chen, "The impact of energy efficient equipment on system power quality," IEEE *Industry Applications Conference, 2000,* vol.5, no., pp.3240-3247.

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

20.1	Software	No
20.2	Hardware	No
20.3	Teaching aides (videos, etc.)	PPTs.
20.4	Laboratory	No
20.5	Equipment	No
20.6	Classroom infrastructure	Yes
20.7	Site visits	May be
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	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	Power Quality
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL758
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	-

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd semx☒Either sem

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof K.R. Rajagopal, Prof. G. Bhuvaneswari, Dr. Anandarup Das, Dr. Amit kumar Jain, Dr. Ramkrishnan Maheshwari, Prof. M. Veerachary

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

13.	**Course objectives** *(about 50 words)***:** • To understand the various power quality issues. • To understand the concept of power and power factor in single-phase and three-phase systems supplying nonlinear loads.

	• To understand the conventional compensation techniques used for power factor correction and load voltage regulation. • To understand the active compensation techniques used for reactive power compensation, load balancing, power factor correction and load voltage regulation. • To understand the active filter techniques used for harmonics elimination. • To understand the power quality improvement in SMPS, UPS, drive systems, lighting system, renewable energy systems.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Overview and definition of power quality (PQ), Sources of pollution, International power quality standards, and regulations. Power quality monitoring Power quality problems. Loads which causes power quality problems. Power factor correction, zero voltage regulation, reactive power compensation, load balancing using load compensation techniques: passive shunt and series compensation, DSTATCOM (Distribution Static Compensators), DVR (Dynamic Voltage Restorers), UPQC (Universal Power Quality Conditioners). Harmonic effects-within the power system, interference with communication Harmonic measurements. Harmonic elimination-using active (shunt, series and hybrid) and passive (shunt and series) filters. Improved power quality converters: single ac-dc converters, bridgeless isolated converter, bridgeless non-isolated converters, multi-pulse converters, multilevel converters, line commutated converters, power quality improvement in SMPS, UPS, drives, welding systems, lighting systems, and renewable energy systems.

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

Module no.	Topic	No. of hours
1	Introduction – definition, terminology and characteristics of electric power quality, power quality standards, power quality monitoring.	3
2	Power quality problems, loads which causes power quality problems: classification	2

3	Passive shunt and series compensation: principle of operation, classification and applications	3
4	Custom power devices (DSTATCOM, DVR, UPQC) :principle of operation, classification, controls and applications	7
5	Passive power filters : principle of operation, classification and applications	3
6	Active filters (shunt, series and hybrid filters) : principle of operation, classification, controls and applications	7
7	Improved power quality converters (ac-dc converters, multi-pulse converters, multilevel converters, line commutated converters etc) : principle of operation, classification, controls and applications	10
8	Power quality improvement in electrical system applications: SMPS, UPS, welding systems, lighting systems, drives, and renewable energy systems.	7
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	Introduction – definition, terminology and characteristics of electric power quality, power quality standards, power quality monitoring.	6
2	Power quality problems, loads which causes power quality problems: classification	4
3	Passive shunt and series compensation: principle of operation, classification and applications	6
4	Custom power devices (DSTATCOM, DVR, UPQC) :principle of operation, classification, controls and applications	14
5	Passive power filters : principle of operation, classification and applications	6

6	Active filters (shunt, series and hybrid filters) : principle of operation, classification, controls and applications	14
7	Improved power quality converters (ac-dc converters, multi-pulse converters, multilevel converters, line commutated converters etc) : principle of operation, classification, controls and applications	20
8	Power quality improvement in electrical system applications: SMPS, UPS, welding systems, lighting systems, drives, and renewable energy systems.	14

19. Suggested texts and reference materials

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

[1] T.J.E. Miller, Reactive Power Control in Electric Systems, John Wiley Sons, Toronto, 1982.

[2] R.M. Mathur, Static Compensators for Reactive Power Control, Contexts Publications, Winnipeg, Canada, 1984.

[3] IEEE Guide for Specification of High Voltage Direct Current Systems Part I-Steady State Performance, IEEE Std. 1030, 1987

[4] D.c. Griffith, “Uninterruptible Power Supplies,” Marcel Dekker Inc, New York, 1989.

[5] J.W. Clark, “AC Power Conditioners-Design applications,” Academic Press, USA 1990.

[6] IEEE Guide for Harmonic Control and reactive compensation of Static Power Converters, IEEE Std. 519-1992

[7] W.E. Kazibwe and M.H. Sendaula, “Electrical Power Quality Control Techniques,” Van Nostrand Reinhold Company, 1993.

[8] G. T. Heydt, Electric Power Quality, second edition, Stars in a Circle, West Lafayette, 1994.

[9] IEEE Recommended Practice for Monitoring Electric Power Quality, IEEE Std. 1159-1995

[10] D.A. Paice, Power Electronic Converter Harmonics-Multipulse Methods for Clean Power, IEEE Press, New York, 1996.

[11] M. H. J. Bollen, Understanding Power Quality Problems: Voltage Sags and Interruptions, IEEE Press Series on Power Engineering, New York, 2000.

[12] J. Arrilaga, N R Wattson and S. Chen, Power System Quality Assessment, John Wiley & Sons, 2000.

[13] Barry W. Kennedy, Power Quality Primer, McGraw Hill Professional, 2000.

[14] C. Sankaran, Power Quality, CRC Press, New York, 2001.

[15] J. Schlabbach, D. Blume and T. Stephanblome, Voltage Quality in Electrical Power Systems, IEE Press Series on Power Engineering and Energy, 2001.

[16] Ghosh Arindam, Ledwich Gerard, Power Quality Enhancement Using Custom Power Devices, Kluwer academic Publishers, London, 2002.

[17] J.C. Das, Power System Analysis-Short Circuit Load Flow and Harmonics, Marcel Dekker Inc. New York, 2002.

[18] E. Acha, V.G. Agelidis, O. Anaya Lara, T.E.J. Miller, Power Electronics Control in Electrical System, Newnes, Woburn,2002.

[19] Ali Emadi, Abdolhosein Nasiri and Stoyan B. Bekiarov, Uninterruptible Power Supplies

And Active Filters, CRC Press, New York,2005.
[20] R. C. Dugan, M. F. McGranaghan and H. W. Beaty, Electric Power Systems Quality, 2nd Edition, McGraw Hill, New York, 2006.
[21] M. H. J. Bollen and Irene Gu, Signal Processing of Power Quality Disturbances, Wiley-IEEE Press, 2006.
[22] T. A. Short, Distribution Reliability And Power Quality, CRC Press, New York, 2006.
[23] Hirofumi Akagi, Edson Hirokazu Watanabe and Mauricio Aredes, Instantaneous Power Theory and Applications to Power Conditioning, Willey Interscience, New Jersey,2007.
[24] Predrag Pejovi C, Three-Phase Diode Rectifiers with Low Harmonics Current Injection Methods, Springer Verlag, London, 2007.
[25] Antonio Moreno Munoz, Power Quality: Mitigation Technologies in a Distributed Environment, Springer-Verlag, London, 2007.
[26] Ewald F. Fuchs and Mohammad A. S. Mausoum, Power Quality in Power Systems and Electrical Machines, Elsevier Academic Press, London, 2008.
[27] K.R. Padiyar, FACTS Controllers in Power Transmission and Distribution, Ist edition, New Age International 2008.
[28] Angelo Baggini, Handbook on Power Quality, John Wiley & Sons, New Jersey, 2008.
[29] R.Sastry Vedam and Mulukutla S. Sarma, Power Quality VAR Compensation In Power Systems, CRC Press, New York, 2009.
[30] J. B. Dixit and Amit Yadav, Electrical Power Quality, University science press, New Delhi, 2010.
[31] Surajit Chattopadhyay, Madhuchhanda Mitra and Samarjit Sengupta, Electric Power Quality, Springer Verlag, London, 2011.
[32] G. Benysek and M. Pasko (Editors), Power Theories for Improved Power Quality, Springer-Verlag London 2012.
[33] Mohd. Hasan A, Wind Energy Systems: Solutions for Power Quality and Stabilization, CRC Press, New York, 2012
[34] Fang Lin Luo and Hong Ye, Renewable Energy Systems: Advanced Conversion Technologies and Applications, CRC Press, 2012.
[35] Fang Lin Luo and Hong Ye, Advanced DC/AC Inverters: Applications in Renewable Energy, CRC Press, 2013.
[36] Q.-C. Zhong and T. Hornik, Control of power inverters in renewable energy and smart grid integration, John Wiley & Sons Ltd., U.K, 2013.
[37] Bhim Singh, Ambrish Chandra and Kamal Al-Haddad, Power Quality: Problems and Mitigation Techniques, John Wiley & Sons Ltd., U.K, 2015.
[38] Paulo Fernando Ribeiro “Time-Varying Waveform Distortions in Power Systems” 1st edition, John Wiley & Sons Ltd., U.K, 2009.

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

20.1	Software	MATLAB, Pspice
20.2	Hardware	-
20.3	Teaching aides (videos,	PPT

	etc.)	
20.4	Laboratory	-
20.5	Equipment	-
20.6	Classroom infrastructure	Projectors, black/white boards
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	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	Power Electronic Converters for Renewable energy systems
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	ELL759
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL751

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☐1stsem☐2ndsem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R. Rajagopal ,Prof. M Veerachary, Prof. G. Bhuvaneswari, Dr. Amit Jain, Dr. Ramkrishan Maheshwari, Dr. Anandarup Das

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** • Understand the applications of power converters in renewable energy systems • Understand operation and control of photovoltaic and wind energy systems with help of power converters • Understand the design techniques of power converters

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Current status and future developments in renewable energy. Requirements for solar and wind power generation from the grid. Solar Power – PV system configurations, Solar cell technologies, Maximum power point tracking, Photovoltaic Inverters different types of topologies and control strategies. Wind power – Wind power energy system, types of wind turbines- fixed speed and variable speed, different types of converters – AC-DC-AC converters, matrix converters, multilevel converter, control of converters. Fuel cells and battery energy storage systems. Grid synchronization and PLL, Grid regulations. Islanding operation. Control of converters for fault operation. Filter design. Relevant IEEE and IEC standards for renewable energy systems.

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

Module no.	Topic	No. of hours
1	Review of current status and future developments in renewable energy	1
2	Requirements for solar and wind power generation from the grid	5
3	Solar Power – PV system configurations, Solar cell technologies, Maximum power point tracking	2
4	Photovoltaic Inverters, topologies and control strategies.	8
5	Wind power – Wind power energy system, types of wind turbines- fixed speed and variable speed, topologies, AC-DC-AC converters, matrix converters, multilevel converter, control of converters	9
6	Fuel cells and battery energy storage systems	5
7	Grid synchronization and PLL, Islanding operation, Control of converters for fault-ride operation, Relevant standards for renewable energy systems	12
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.

1. Remus Teodorescu, Marco Liserre and Pedro Rodríguez, Grid Converters for Photovoltaic and Wind Power Systems , 2011 John Wiley & Sons, Ltd.
2. Bimal K Bose, Modern Power Electronics and AC Drives, Prentice Hall, edition 1, 2001.
3. Recent journal and conference papers.

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	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	30
21.2	Open-ended problems	35
21.3	Project-type activity	35
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Switched Mode Power Conversion**
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	**ELL760**
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL751

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☐1stsem☐2ndsem☒Either sem -

11.	**Faculty who will teach the course** Prof. M Veerachary, Prof. Bhim Singh, Ramkrishan Maheshwari, Dr. Anandarup Das, Prof. G. Bhuvaneshwari, Dr. Amit Kumar Jain

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** • Understand the concepts and basic operation of the switched mode power converter • Understand the analysis and modeling of the switched mode power converter • Understand the design techniques of the switched mode power converter

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Introducing the basic of switch-mode power conversion.

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

Module no.	Topic	No. of hours
1	Review of power switching devices and basic converter topologies	2
2	Volt-sec/ charge-sec balance, non-isolated and isolated topologies Push-pull and forward converter Flyback, Half-bridge and Full-bridge topologies	12
3	Magnetics Design, Introduction to core materials and geometries,Inductor and transformer designs.	6
4	Steady-state and dynamic modeling of the switched mode power converter and converter transfer function formulation	8
5	Controller Design, Voltage mode and current mode control strategies, ramp compensation, introduction to PWM ICs, Filter Design and Negative impedance instability of dc-dc converters.	8
6	Introduction to Front end PWM rectifiers, Single phase and three-phase topologies	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

19. Suggested texts and reference materials

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

1. Abraham I. Pressman, Keith Billings, and Taylor Morey, Switching Power Supply Design, 3rd Ed.,McGraw-Hill Professional, 1 May 2009.

2. Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, 2nd Ed., Springer (India) Pvt. Ltd., 2005.

3. Christophe P. Basso, Designing Control Loops for Linear and Switching Power Supplies: A Tutorial Guide, Artech House Publishers, 1 Oct 2012.

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

20.1	Software	MATLAB, PSPICE
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	30
21.2	Open-ended problems	35
21.3	Project-type activity	35
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Power Electronics for Utility Interface**
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	**ELL761**
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL751

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☐1stsem☐2ndsem☒Either sem -

11.	**Faculty who will teach the course** **Prof. Bhim Singh, Prof. K R Rajagopal, Prof. M Veerachary, Dr. A K Jain, Dr. Anandarup Das, Dr. Ramkrishan Maheshwari, Prof. G. Bhuvaneshwari**

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

13.	**Course objectives** *(about 50 words)***:** • Understand the requirement for the converters used for utility interface • Understand the operation of the converters used for utility interface • Understand the analysis, design, and control of the converters used for utility interface

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Overview of power electronic converters for utility applications, Converter requirements for Grid-interface, Harmonic compensation, Instantaneous power theory, STATCOM and active filtering and Control of converters under grid-faults.

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

Module no.	Topic	No. of hours
1	Overview of power electronic converters for utility applications	2
2	Converter requirements for Grid-interface. Standards, anti-islanding requirement, ride through capability, grid codes, etc.	2
3	Grid synchronization of single and three-phase inverters, PLL	5
4	Overview of modulation techniques, control of converters for utility, Modelling of the grid connected converters	8
5	Harmonic compensation, synchronous-dq, and stationary αβ-frames	5
6	Filter design – LCLdesign, Passive damping methods, Active damping methods	5
7	Instantaneous power theory, d-q-z instantaneous power theory	5
8	STATCOM and active filtering, Reactive power compensation, Power quality and power filters, Shunt active power filter.	5
9	Control of converters under grid-faults	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

19. Suggested texts and reference materials

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

1. Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, 2nd Ed., Springer (India) Pvt. Ltd., 2005.

2. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, Wiley Int., Jan 2011.

3. Hirofumi Akagi, Edson Hirokazu Watanabe, Mauricio Aredes, Instantaneous Power Theory and Applications to Power Conditioning, Wiley-IEEE Press, Feb 2007.

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	30
21.2	Open-ended problems	35
21.3	Project-type activity	35
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/~~Centre~~ proposing the course**	ElectricalEngineering
2.	**Course Title** *(< 45 characters)*	Intelligent Motor Controllers
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL762
6.	**Status** (*category* for *program*)	PE, B.Tech Stream Elective

7.	**Pre-requisites** (course no./title)	ELL305 for UGS

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	Supercedes any existing course	None

9.	**Not allowed for** (indicate program names)	-

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R.Rajagopal, Prof.G. Bhuvaneswari, Prof. M. Veerachary, Dr. Amit Kumar Jain, Dr.RamkrishanMaheswari, Dr. Anandarup Das	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** To introduce the students to intelligentcontrol algorithms/ techniquesused in control of DC and AC electric drives.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** Fundamental concepts in control of electric drive systems. Intelligent Control algorithms used for electric drive systems. Application of Fuzzy Logic, Neural Networks, Genetic Algorithm, Hybrid Fuzzy and Nonlinear Control of Power Converters and Drives. Other recent topics on Intelligent Control of Drives

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

Module no.	Topic	No. of hours
1	**Fundamental concepts in control of electric drive systems**	4
2	**Fuzzy Logic Control of Drives**	8
3	**Artificial Neural Network control of Drives**	8
4	**Genetic Algorithm based control of Drives**	8
5	**Hybrid Fuzzy/PI Control of Drives**	8
6	**Other recent topics on Intelligent Control of Drive**	6
COURSE TOTAL *(14 times 'L')*		42

16. Brief description of tutorial activities

Module No	Topic	No of Tutorials

17. Brief description of laboratory activities

Module No.	Experiment description	No. of sessions

18. Suggested texts and reference materials

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

1. Tze-Fun Chan, Keli Shi, "Applied Intelligent Control of Induction Motor Drives", Wiley, 2011
2. Orłowska-Kowalska, Teresa, Blaabjerg, Frede, Rodríguez, José ,"Advanced and Intelligent Control in Power Electronics and Drives", Springer, 2014
3. Maurizio Cirrincione , Marcello Pucci , and Gianpaolo Vitale. "Power Converters

and AC Electrical Drives with Linear Neural Networks",CRC Press, 2012.

4. Lakhmi C. Jain, Clarence W. de Silva, "Intelligent Adaptive Control: Industrial Applications", CRC Press, 1998

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

19.1	Software	
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	30
20.2	Open-ended problems	35
20.3	Project-type activity	35
20.4	Open-ended laboratory work	0
20.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	Advanced Electric Drives
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL763
6.	**Status** (*category* for *program*)	PE + B.Tech Stream Elective

7.	**Pre-requisites** (course no./title)	ELL305 for UG

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	Supercedes any existing course	None

9.	**Not allowed for** (indicate program names)	-

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R.Rajagopal, Prof.G. Bhuvaneswari, Prof. M. Veerachary, Dr. Amit Kumar Jain, Dr.Ramkrishan Maheswari, Dr. Anandarup Das	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** To introduce the students to advanced techniques used to control DC and AC electric machines drives.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** **Types of Controllers**: Proportional-Integral Control, Hysteresis Control etc. **Advanced DC Drives**: Cascaded Control Loop Structure, Control Loop Design etc. **Control of BLDC drive**: Modeling and Control of BLDC Drive. **Review of Power Converter and Modulation Techniques**: Modeling of Power Converters, Sinusoidal Pulse-Width Modulation, Space Vector Pulse-Width Modulation. **Field Oriented Control (FOC) of AC Machines**: Generalized Space-Phasor Model of AC Machines in different Flux Frames of References, Control Principle, FOC of Permanent Magnet Synchronous Machine (PMSM), FOC of Squirrel Cage Induction Machine (SQIM). **Direct Torque Control (DTC) of AC Machines**: Control Principle, DTC of Squirrel Cage Induction Machine (SQIM).

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

Module no.	Topic	No. of hours
1	**Types of Controllers**	2
2	**Advanced DC Drives**	8
3	**Control of BLDC drive**	5
4	**Review of Power Converter and Modulation Techniques**	5
5	**Field Oriented Control (FOC) of AC Machines**	16
6	**Direct Torque Control (DTC) of AC Machines**	6
COURSE TOTAL *(14 times 'L')*		42

16. Brief description of tutorial activities

Module No	Topic	No of Tutorials

17. Brief description of laboratory activities

Module No.	Experiment description	No. of sessions

18. Suggested texts and reference materials

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

1. W. Leonhard, "Control of Electrical Drives", Springer, 3rd ed. 2001
2. P. Vas, "Sensorless Vector and Direct Torque Control", Oxford University Press, 1998
3. B. K. Bose, "Modern Power Electronics and AC Drives", Prentice Hall, 1986.
4. Ramu Krishnan, "Permanent Magnet and BLDC Motor Drives", CRC Press.
5. Ramu Krishnan, "Electric Motor Drives", Prentice Hall.
6. N. Mohan, "Advanced Electric Drives: Analysis, Control and Modeling using Simulink", MNPERE

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

19.1	Software	
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	
20.2	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**	
2.	**Course Title** *(< 45 characters)*	COMPUTER AIDED DESIGN OF POWER ELECTRONIC SYSTEMS
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL768
6.	**Status** (*category* for *program*)	PE + UG

7.	**Pre-requisites** (course no./title)	ELL751 for PG, ELL209 for UG

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	Not Applicable

10.	**Frequency of offering**	☐Every sem ☐1stsem ☐2ndsem ☒Either sem -

11.	**Faculty who will teach the course** Prof. M. Veerachary, Dr. Amit Kumar jain, Dr. R. K. Maheshwari, Dr. Anandarup Das, Prof.K.R.Rajagopal, Prof. Bhim Singh

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** To train the students in the emerging area of computer aided design and analysis of power electronic systems, application oriented control of power electronic systems, Computer based design problems on power electronic converter systems will be discussed.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Introduction to modern simulation tools used for the power electronic systems analysis such as PSPICE, MATLAB, PSIM, SABER etc, Modeling of power electronic systems, filters designs. Introducing to advanced modeling techniques and their transformation into software platform, Closed-loop power electronic systems modeling and their simulation.

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

Module no.	Topic	No. of hours
1	Review of power electronic software simulation tools, SPICE, PSPICE, SABER, PSIM, Simplorer, Advantages and disadvantages of circuit, net-list oriented simulators, introduction to MATLAB/SIMULINK for Power Electronic Systems Simulations, Power system block set and illustrative examples.	12
2	PSPICE and MATLAB/SIMULINK development and simulation of dc-dc converters, inverters, ac-voltage controllers, implementation of various PWM techniques.	12
3	Introduction to filter design, filter design for rectifiers, dc-dc converters, inverters, interfacing and stability issues of power electronic systems with filters, design problems and ovear all power electronic system simulations, design problems.	18
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
	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
	Learning of new modeling techniques of power electronic devices and topologies, emulating characteristics and switching mechanism of different switching devices	7
	Development of reliable software compatible models of power electronic systems, simulation issues on PWM rectifiers and control strategies and their application to Inverter, UPS, etc,.	7
	Development of reliable software compatible models of filter components, high frequency transformers and inductors, simulation issues on integration of high frequency inductors/ transformers within power electronic systems, etc.	6

19. Suggested texts and reference materials

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

1. Switching Power supply design – Abraham I Pressman
2. Dynamic Simulation of Electric Machinery using MATLAB/SIMULINK – Chee-Mun Ong
3. PSPICE and MATLAB for Electronics-An integrated approach – Jhon Okyere Attia
4. Fundamental of Power Electronics: Robert Erickson
5. Power Electronics, Circuits, Devices and Applications: Muhammad H. Rashid
6. Power Electronic, Devices, Applications, and Passive Components: Barry W. Williams

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

20.1	Software	Existing facilities in terms of software are sufficient
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	30%
21.2	Open-ended problems	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0%
21.5	Others (please specify)	0%

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	DIGITAL CONTROL OF POWER ELECTRONICS AND DRIVE SYSTEMS
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	**ELL850**
6.	**Status** (*category* for *program*)	PC

7.	**Pre-requisites** (course no./title)	ELL750, ELL751

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	Not Applicable

10.	**Frequency of offering**	☐Every sem☐1stsem☒2ndsem☐Either sem -

11.	**Faculty who will teach the course** Prof. M. Veerachary, Dr. Amit Kumar jain, Dr. R. K. Maheshwari, Dr. Anandarup Das, Prof.K.R.Rajagopal, Prof. Bhim Singh, Prof. G. Buvaneshwari

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** To train the electrical engineering students, having background in power electronics and electrical machines, in the area of digital control of power electronics converters and drives. The introduction of this course essentially begins with giving exposure to digital control engineering, laplace and z-transforms, sampling issues and then extending the thoery to power electronic and drive systems. The course is focused

	on different applications of power processing schemes using power electronic converters and drives. Few cases studies, stimulating new developments, of digital control power electronic systems will be discussed.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Review of Digital signal processors, Laplace trasforms, Theory of sampling, z-transformations, sampling techniques, Digital PWM generation schemes, Realization of different PWM's using DSP's, Control of DC-DC Converters,Inverters, DC and Ac Machines.

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

Module no.	Topic	No. of hours
1	Review of Digital signal processors/Microcontrollers	1
2	Introduction to DSP/micro-controllers and thier application to power electronic conversion	2
3	Brief introduction to Laplace transform, Theory of sampling, z-transformations, sampling techniques in power electronic converters	2
4	Signal analysis, Digital PWM generation schemes, Realization of different PWM's using DSP's	2
5	Algorithms and programming of digital controllers,Implementation aspects and application of modern digital controllers	4
6	Control of DC-DC Converters	3
7	Control of Inverters	5
8	Control of power factor correction	3
9	Control of DC Machine	3
10	Control of AC Machine	8
11	Control of PMBLDC, PMSM and SRM	9
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

	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
	Learning specific DSP architecture and programming	6
	PWM strategies and their implementation aspects	6
	Power electronic sensing circuits design and conditioning of real-time signals	6
	Sampling of real-time signal and their processing in digital domain	6
	Interfacing of Power Electronic Systems to DSP, hands-on experience in digital domain	6

19. Suggested texts and reference materials

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

1. Digital Signal Processing: Steven W Smith
2. Digital Control System Design: Santina, Stubberud, Hostetter
3. DSP based electromechanical motion control: H. A. Toliyat, Steven G. Campbell
4. Modern Control Systems: John A Borrie
5. Switching Power supply design – Abraham I Pressma
6. Fundamental of Power Electronics: Robert Erickson

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

20.1	Software	Existing facilities in terms of software are sufficient

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	30%
21.2	Open-ended problems	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0%
21.5	Others (please specify)	0%

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/~~Centre~~ proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	CAD of Electrical Machines
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL851
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	

8.	**Status vis-à-vis other courses***(give course number/title)*	
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	Supercedes any existing course	No

9.	**Not allowed for** (indicate program names)	

10.	**Frequency of offering**	☒Either sem

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. .K.R. Rajagopal, Prof. G. Bhuvaneswari, Dr. Amit Kumar Jain, Prof M Veerachary, Dr. Ramkrishnan Maheshwari, Dr. Anandarup Das	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** To study the conventional and computer aided design of different electrical machines such as transformers, dc machines, three phase induction machines and synchronous machines, permanent magnet motors, switched reluctance motor.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** Introduction of Standards and standardizations, specifications, frame size, basic design methodology and engineering considerations. Properties of electric, magnetic and insulating materials. Choice of materials, frames etc. Computerization of design procedures. Optimization techniques and their application to design problems. Design of large and h.p. motors. Database and knowledge based expert systems. Development of PC based software.

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

Module no.	Topic	No. of hours
1	Introduction of Standards and standardizations, specifications, frame size	3
2	Classes of insulating materials, heating and cooling of electrical machines	2
3	Philosophy of computer aided design, advantages and limitations	2
4	Basic design methodologies and engineering considerations,	2
5	Specific electrical and magnetic loadings	2
6	Output equations of transformer and rotating machines separation of parameters	2
7	Design of transformer core, yoke and windings	2
8	Computation of no load current, cooling system design	1
9	Core and armature design of dc and three phase ac machines	3
10	Design of field system of dc and synchronous machines	2
11	Rotor design of three phase induction motors	2
12	Estimation and performance from design data.	2
13	Computerization of design procedure, use of graphic tools in computer	2
14	Analysis and synthesis methods	2
15	Development of computer program and performance predictions	2
16	Development of PC based software's	2
17	Computer aided design of transformer, dc machine	4

18	Computer aided design of induction and synchronous machines	5
Course Total *(14 Times 'L')*		42

Brief description of tutorial activities

16. Discussion on numerical problems based on the conventional design and CAD (Computer Aided Design) of various electrical machines. The practices and exercises will include the CAD of the various machines using necessary CAD tools/software.

17. Brief description of laboratory activities

Module No.	Experiment description
COURSE TOTAL *(14 times 'P')*	

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 of Standards and standardizations, specifications, frame size	6
2	Classes of insulating materials, heating and cooling of electrical machines	4
3	Philosophy of computer aided design, advantages and limitations	4
4	Basic design methodologies and engineering considerations,	4
5	Specific electrical and magnetic loadings	4
6	Output equations of transformer and rotating machines separation of parameters	4

7	Design of transformer core, yoke and windings	4
8	Computation of no load current, cooling system design	2
9	Core and armature design of dc and three phase ac machines	6
10	Design of field system of dc and synchronous machines	4
11	Rotor design of three phase induction motors	4
12	Estimation and performance from design data.	4
13	Computerization of design procedure, use of graphic tools in computer	4
14	Analysis and synthesis methods	4
15	Development of computer program and performance predictions	4
16	Development of PC based software's	4
17	Computer aided design of transformer, dc machine	8
18	Computer aided design of induction and synchronous machines	10

19. Suggested texts and reference materials

[1] J. Scott, “Design Data and Practical Information for Electronic Transformers and Inductors” Jack Scott, 1995.
[2] C.W.T. McLyman, “Magnetic Core Selection for Transformers and Inductors: A User's Guide to Practice and Specification,” Marcel Dekker, Inc., Second Edition, New York, 1997.
[3] B. W. Kennedy, “Energy Efficient Transformers,” McGraw-Hill, New York, 1998.
[4] R. M. D. Vecchio, “Transformer Design Principles: With Applications to Core-Form Power Transformers” Taylor and Francis, 2000.
[5] A. Still, “Principles of Electronic Transformer Design,” November 2002.
[6] J.H. Kuhlmann and N.F. Tsang, “*Design of Electrical Apparatus*,” Wiley and Sons, Third Edition, New York, 1950.
[7] A. Still and C.S. Siskind, “*Elements of Electrical Machine Design*,” McGraw-Hill, New York, 1954.
[8] C.G. Veinott, “Fractional Horse-Power Electric Motors,” McGraw-Hill, New York, 1959.

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

19.1	Software	CAD tools for machine design, Graphic tools
19.2	Hardware	
19.3	Teaching aides (videos,	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Furnished with the projector and audio-visual
19.7	Site visits	

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

20.1	Design-type problems	30%
20.2	Open-ended problems	35%

20.3	Project-type activity	35%
20.4	Open-ended laboratory	0
20.5	Seminars and	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	Condition Monitoring of Electrical Machines
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL852
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL750

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem ☐1st sem ☐2nd sem ☒Either sem

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof K.R. Rajagopal, Prof. G. Bhuvaneswari,Dr. Amit kumar Jain, Prof. M. Veerachary, Dr. Ramkrishnan Maheshwari, Dr. Anandarup Das

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

13.	**Course objectives** *(about 50 words)***:** The objective of this course is to familiarize the students with fundamental issues related to condition and monitoring of electrical machines. The causes, diagnostic and possible mitigation methods are integral part of the course.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** **Types of faults including faults in** The course includes the need for condition monitoring. Three main subdivisions of the course are types of fault and their symptoms, diagnostic methods to identify these faults and a deep signal processing analysis for fault diagnosis. The various components prone to fault are stator, rotor, shaft, gear box, bearing etc. The diagnosis methods includes diagnosis based on temperature, infrared signal, vibration, noise, motor current signature analysis etc. various signal processing techniques such as fuzzy logic, neural network from fault diagnosis point of view are also included in this course.

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

Module no.	Topic	No. of hours
1	Introduction:- Need for condition monitoring and syllabus overview	1.5
2	Types of faults and their signatures or symptoms:	
	Stator faults	3
	Rotor faults	3
	Bearing fault	1.5
	Gear box faults	1.5
	Shaft fault	1.5
	Air gap irregularities	1.5
3	Diagnostic methods to identify these faults	
	Electromagnetic field monitoring	1.5
	Temperature measurements, Infrared recognition	1.5
	Noise and vibration monitoring	1.5
	Chemical analysis	1.5
	Acoustic noise measurements	1.5
	Motor current signature analysis (MCSA)	4.5
	Model, artificial intelligence and neural network based techniques.	4.5
	Radio frequency (RF) emissions monitoring	1.5
4	Details of signal processing techniques used for fault diagnostics	
	Artificial neural network	3
	Fuzzy logic etc	3
	Application of signal processing techniques on Motor current signature analysis (MCSA)	6
	Concluding remarks	1.5
COURSE TOTAL *(14 times 'L')*		**45**

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	Need for condition monitoring	4
2	Types of faults and their signatures or symptoms	24
3	Diagnostic methods to identify these faults	36
4	Details of signal processing techniques used for fault diagnostics	27

19. Suggested texts and reference materials

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

[1] Amiya RanjanMohanty “Machinery Condition Monitoring: Principles and Practices”, first edition, CRC Press, 2015.

[2] Hamid A. Toliyat, Subhasis Nandi, Seungdeog Choi and Homayoun Meshgin-kelk “Electric Machines Modeling, Condition Monitoring,and Fault Diagnosis”,CRC Press, 2013.

[3] W. H. Tang, Q. H. Wu “Condition Monitoring and Assessment of Power Transformers Using Computational Intelligence” 1st edition, Springer, 2011.

[4] Rolf Isermann “Fault-Diagnosis Applications” 1st edition, Springer, 2011.

[5] Peter Tanner, Li Ran, Jim Penman and Howard Sedding “Condition Monitoring of Rotating Electrical Machines” 1st edition, The Institution of Engineering and Technology, 2008.

[6] B. K. N. Rao “Handbook on condition Monitoring”, first edition, Elsevier advanced technology, 1996.

[7] R. R. Schoen, T. G. Habetler, F. Kaman, R. *G.* Banhcld, “ Motor bearing damage detection using stator current monitoring”, *IEEE Tranr.Ind .Applns.,vol*.31, no . 6, pp 1274-79, Nov-Dec 1995.

[8] R. R. Schoen, B. K.Lin, T. G. Habetler, J. H. Schlag, *S.* Farag, “Anunsupervised on-line system for induction motor fault detection usingstator current monitoring,” *IEEE Trans.*

Ind. Appl., vol.31, no. 6, pp1280-86, Nov-Dec 1995.
[9] B. Yazid, *G.* B. Kliman, W. J. Premerlani, R. A. Koegl, *G.* B.Robinson and A. Abdel-Malek, “An adaptive, on-line, statisticalmethod far bearing fault detection using stator anent”, *IEEE-IAS Annual Meeting conference,* pp 213- 220, New Orleans, LA, 1997.
[10] *G.* B. Kliman, W. 1. Premerlani, R. A. Koegland D. Hoeweler, “Anew approach to on-line fault detection in ac motors”, *IEEE-IAS Annual Meeting Conference,* pp.687-693. San Diego, CA, 1996.
[11] Penman, H. *G.* Sedding, B. A. Lloyd, W. T. Fink. “Detection andlocation of inter turn short circuits in the stator windings of operatingmotors”, *IEEE Trans. Energy Conv.,* vol.9, no.4, Dec 1994.
[12] K. A. Toliyat and T. A. Lipo, Transient analysis of *cage* inductionmachines under stator, rotor bar and end ring faults”, *IEEE Trans.Energy Conv.* vol.10, no.2, June 1995.
[13] S. Williamson and P. Mirzoian, Analysis of cage induction motorwith stator winding faults”. *IEEE-PES.* Summer Meeting, July 1984.

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

20.1	Software	Motor CAD, Flux, Motor Solvev2.3.
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	PPTs, research papers.
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	30%
21.2	Open-ended problems	35%
21.3	Project-type activity	35%
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/~~Centre~~ proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	Advanced Topics in Electrical Machines
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL853
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL750

8.	**Status vis-à-vis other courses***(give course number/title)*	
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	Supercedes any existing course	No

9.	**Not allowed for** (indicate program names)	

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R. Rajagopal, Prof. G. Bhuvaneswari, Dr. Amit Kumar Jain, Dr. Anandarup Das, Dr. Ramkrishnan Maheshwari, Prof. M. Veerachary	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** The main objective of the course is to enhance the knowledge of the students in the field of advancement in electrical machines including their design, construction, operating principle;control and miscellaneous applications. Contents of the course are such that the study facilitates the job of the students in real field.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** Introduction to Advanced Topics in Electrical Machines, Synchronous Reluctance Machines, Hybrid Motors, Linear Motors, Super conducting Machines, PCB Motors, Micro motors, Written Pole Machines.Applications of all these advanced motors in field of Robotics, Automation, Electric Vehicles, pumping etc. The rating consideration and special advantages with these motors in various practical or field conditions is primary objective of this course. Other Advanced machines, Case Studies, Computer Aided Simulation of Electrical Machines are added for enhanced understanding of the topic.

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

Module no.	Topic	No. of hours
1	Introduction to Advanced Topics in Electrical Machines	3
2	Synchronous Reluctance Machines	3
3	Hybrid Motors	6
4	Linear Motors	6
5	Super conducting Machines	6
6	PCB Motors	3
7	Micro motors	3
8	Written Pole Machines	3
9	Applications in Robotics, Industry Automation, Electric Vehicles, Aerospace and Defense Systems, etc.	5
10	Other Advanced machines	2
11	Case Studies, Computer Aided Simulation of Electrical Machines	2
COURSE TOTAL *(14 times 'L')*		42

16. Brief description of tutorial activities

Tutorial consists of the exercises of numerical problems and practice of the simulations related to the design, construction, operation of machines and its drives using the software such asMATLAB/PSIM/PSPICE-ORCAD. Tutorial activities will be made more interactive by assignments and evaluations of relevant exercises.

17. Brief description of laboratory activities

Module No.	Experiment description
COURSE TOTAL *(14 times 'P')*	

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 Advanced Topics in Electrical Machines	6
2	Synchronous Reluctance Machines	6
3	Hybrid Motors	12
4	Linear Motors	12
5	Super conducting Machines	12
6	PCB Motors	6
7	Micro motors	6
8	Written Pole Machines	6
9	Applications in Robotics, Industry Automation, Electric Vehicles, Aerospace and Defense Systems, etc.	10
10	Other Advanced machines	4

11	Case Studies, Computer Aided Simulation of Electrical Machines	4

19. Suggested texts and reference materials

[1] Arthur Eugene Fitzgerald, Charles Kingsley, Stephen D. Umans "*Electrical Machinery*" Tata McGraw-Hill publishing Company Limited, New Delhi, India, 2009.

[2] I. Boldea and S.A. Nasar, "Electric Drives," CRC Press, 1998.

[3] I. Boldea and S.A. Nasar, "Vector Control of AC drives," CRC Press, 1992.

[4] Guru Bhag Singh, H. Hiziroglu "*Electric Machinery And Transformers*" 3r Oxford University Press, 2005.

[5] M. Azizur Rahman and Ruifeng Qin, "A Permanent Magnet Hysteresis H Synchronous Motor for Electric Vehicles," *IEEE Transactions on Indu Electronics*, vol. 44, no. 1, February 1997.

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

19.1	Software	MATLAB/PSIM/PSPICE-ORCAD/Caspoc
19.2	Hardware	
19.3	Teaching aides (videos, etc.)	
19.4	Laboratory	
19.5	Equipment	
19.6	Classroom infrastructure	Classroom with the facility of projector, mike and sound system
19.7	Site visits	

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

20.1	Design-type problems	30%
20.2	Open-ended problems	35%
20.3	Project-type activity	35%
20.4	Open-ended laboratory work	0
20.5	Simulation based problems	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/~~Centre~~ proposing the course**	ElectricalEngineering
2.	**Course Title** *(< 45 characters)*	Selected Topics in Electrical Machines
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL854
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL750

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	Supercedes any existing course	None

9.	**Not allowed for** (indicate program names)	-

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R.Rajagopal, Prof.G. Bhuvaneswari, Dr. Amit Kumar Jain, Dr.RamkrishanMaheswari, Dr. Anandarup Das, Prof. M. Veerachary,	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** To introduce the students to recent developments and techniques in the area of electric machines and their applications.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** **Recent developments in the area of electrical machines**

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

Module no.	Topic	No. of hours
1	**Recent developments in the area of electrical machines**	42
COURSE TOTAL *(14 times 'L')*		42

16. Brief description of tutorial activities

Module No	Topic	No of Tutorials

17. Brief description of laboratory activities

Module No.	Experiment description	No. of sessions

18. Suggested texts and reference materials

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

1. Recent Journals/Transaction/Conference papers
2. New Books in the area of electric drives

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

19.1	Software	
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	
20.2	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** *(< 45 characters)*	**High Power Converters**
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	**ELL855**
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL751

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☐1stsem☐2ndsem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K Rajagopal ,Prof. M Veerachary, Prof. G. Bhuvaneswari, Dr. Amit Jain, Dr. Ramkrishan Maheshwari, Dr. Anandarup Das

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

13.	**Course objectives** *(about 50 words)***:** • Understand the concepts and basic operation of high power converters • Understand different pulse width modulation techniques • Understand the design techniques of high power system

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Introduction to High Power devices – IGBT, Thyristor, IGCT. Different topologies of high power converters – Voltage Source and current source converter, 2- level converters, 3 level NPC converter, Cascaded H-Bridge Multilevel Converters, Modular multilevel converters. Pulse width modulation techniques for high power converters – Level shifted PWM, Phase shifted PWM, Space vector PWM for multilevel converters. Design of high power converter components, operational issues, fault tolerant operation, reliability, mechanical design. Design of filters for high power converters. Relevant IEEE and IEC standards for high power converters.

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

Module no.	Topic	No. of hours
1	Review of converters used in high power applications and their standards	4
2	Introduction to high power devices, IGBT, Thyristor, IGCT	6
3	Topologies of high power converters, Voltage and current source converters, 2 and 3-level converter topologies, NPC converter, Cascaded H-Bridge Multilevel Converters, Modular multilevel converters	10
4	Pulse width modulation techniques for high power converters – Level and Phase shifted PWMs, Space vector PWM for multilevel converters.	10
5	Design of high power converters and its components	6
6	Operational issues, fault-tolerant operation, reliability, mechanical design.	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

19. Suggested texts and reference materials

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

1. Bin Wu, High-Power Converters and AC Drives, Wiley 3rd edition, 2006.
2. Recent journal and conference papers.

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	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	30
21.2	Open-ended problems	35
21.3	Project-type activity	35
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Advanced topics in Power Electronics**
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	ELL856
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL751

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☐1stsem☐2ndsem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K Rajagopal ,Prof. M Veerachary, Prof. G. Bhuvaneswari, Dr. Amit Jain, Dr. Ramkrishan Maheshwari, Dr. Anandarup Das

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** • Understand and explore advanced and recent topics in power electronics

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Upcoming power electronic devices- SiC and GaN devices. Design of power electronic converters, Introduction to soft-switching in dc-dc and dc-ac applications.

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

Module no.	Topic	No. of hours
1	Upcoming power electronic devices- SiC and GaN devices, Design of power electronic converter.	10
2	Introduction to soft-switching techniques, soft-switching power converter topologies, classification.	16
3	Quasi-resonant, full resonant converter, ZCS,ZVS, ZCT,ZVT and ZCZVT	16
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.

Recent journal and conference papers.

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	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	30
21.2	Open-ended problems	35
21.3	Project-type activity	35
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Selected Topics in Power Electronics**
3.	**L-T-P structure**	**3-0-0**
4.	**Credits**	**3**
5.	**Course number**	**ELL857**
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL751

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☐1stsem☐2ndsem☒Either sem -

11.	**Faculty who will teach the course** **Dr. Bhim Singh, Prof. K. R. Rajagopal, Prof. M. Veerachary, Dr. Amit Kumar Jain, Dr. Ramkrishan Maheshwari, Dr. Anadarup Das, Prof. G. Bhuvaneshwari**

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

13.	**Course objectives** *(about 50 words)***:** To introduce recent developments in power electronics.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Recent developments in power electronics.

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

Module no.	Topic	No. of hours
	Recent developments in power electronic	42
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.

Recent journal and conference papers.

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	30
21.2	Open-ended problems	35
21.3	Project-type activity	35
21.4	Open-ended laboratory work	0
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/~~Centre~~ proposing the course**	Electrical Engineering
2.	**Course Title** *(< 45 characters)*	Advanced Topics in Electric Drives
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL858
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL752

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	Supercedes any existing course	None

9.	**Not allowed for** (indicate program names)	-

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R.Rajagopal, Prof. G. Bhuvaneswari, Prof. M. Veerachary, Dr. Amit Kumar Jain, Dr.RamkrishanMaheswari, Dr. Anandarup Das	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** To introduce the students to advancedtechniquesused inElectric Drives and Applications.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** Advanced PWM Techniques.Control of switched reluctance motor drives.Control of slip-ring induction motor drives.Self-commissioning and self-adaptation techniques in drives.Sensor-less techniques in drives.Fault tolerant controllers and converters. Other recent topics on drives.

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

Module no.	Topic	No. of hours
1	Advanced PWM Techniques	8
2	Control of slip-ring induction motors	8
3	Control of switched reluctance motors	6
4	Self Commissioning and self-adaptation techniques in drives	5
5	Sensor-less techniques in drives	5
6	Fault Tolerant controllers and converters	5
7	Other recent topics on drives	5
COURSE TOTAL *(14 times 'L')*		42

16. Brief description of tutorial activities

Module No	Topic	No of Tutorials

17. Brief description of laboratory activities

Module No.	Experiment description	No. of sessions

18. Suggested texts and reference materials

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

1. W. Leonhard, "Control of Electrical Drives", Springer, 3rd ed. 2001
2. P. Vas, "Sensor-less Vector and Direct Torque Control", Oxford University Press, 1998

3. D. Grahame Holmes, Thomas A. Lipo, "Pulse Width Modulation for Power Converters: Principles and Practice", Wiley & Sons, 2001
4. Ramu Krishnan, "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications", IEEE Industrial Electronics Series, 2001
5.T J E Miller, "Switched Reluctance Motors and their Control", Oxford University Press, London, 1993
6.Gonzalo Abad, Jesus Lopez, Miguel Rodriguez, Luis Marroyo, GrzegorzIwanski, "Doubly Fed Induction Machine: Modeling and Control for Wind Energy Generation" Wiley, 2011
7. Journals/Transaction papers on recent topics.

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

19.1	Software	
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	30
20.2	Open-ended problems	35
20.3	Project-type activity	35
20.4	Open-ended laboratory work	0

20.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/~~Centre~~ proposing the course**	ElectricalEngineering
2.	**Course Title** *(< 45 characters)*	Selected Topics in Electric Drives
3.	**L-T-P structure**	3-0-0
4.	**Credits**	3
5.	**Course number**	ELL859
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	ELL752

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	Supercedes any existing course	None

9.	**Not allowed for** (indicate program names)	-

10.	**Frequency of offering**	☐Every sem☐1st sem☐2nd sem☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R.Rajagopal, Prof.G. Bhuvaneswari, Prof. M. Veerachary, Dr. Amit Kumar Jain, Dr.Ramkrishan Maheswari, Dr. Anandarup Das	
12.	**Will the course require any visiting faculty?**	No

13.	**Course objective** *(about 50 words)***:** To introduce the students to recent developments andtechniquesin the area ofelectric drives and their applications.

14.	**Course contents** *(about 100 words) (Include laboratory/design activities)***:** **Recent developments in the area of electric drives**

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

Module no.	Topic	No. of hours
1	Recent developments in the area of electric drives	42
COURSE TOTAL *(14 times 'L')*		42

16. Brief description of tutorial activities

Module No	Topic	No of Tutorials

17. Brief description of laboratory activities

Module No.	Experiment description	No. of sessions

18. Suggested texts and reference materials

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

1. Recent Journals/Transaction/Conference papers
2. New Books in the area of electric drives

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

19.1	Software	
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	30
20.2	Open-ended problems	35
20.3	Project-type activity	35
20.4	Open-ended laboratory work	0
20.5	Others (please specify)	0

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)*	Electrical Machines Laboratory	
3.	**L-T-P structure**	(0-0-3)	
4.	**Credits**	1.5-credits	
5.	**Course number**	ELP850	
6.	**Status** (*category* for *program*)	PC	

7.	**Pre-requisites** (course no./title)	No

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem ☒1stsem ☐2ndsem ☐Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh, Prof. K.R.Rajagopal, Prof.G. Bhuvaneswari, Prof. M. Veerachary, Dr. Amit Kumar Jain, Dr.Ramkrishan Maheswari, Dr. Anandarup Das

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

13.	**Course objectives** *(about 50 words)***:** To Introduce the practical concepts of basic and advanced electrical machines in the laboratory.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Experiments on Electrical Machines and their control.

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

	Total	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

19. Suggested texts and reference materials

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

1. Laboratory Manual

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	Yes
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	0
21.2	Open-ended problems	0
21.3	Project-type activity	30%
21.4	Open-ended laboratory work	70%
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Power Electronics Laboratory**
3.	**L-T-P structure**	**0-0-3**
4.	**Credits**	**1.5**
5.	**Course number**	**ELP851**
6.	**Status** (*category* for *program*)	PC

7.	**Pre-requisites** (course no./title)	Power Electronics

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem☒1stsem☐2ndsem☐Either sem -

11.	Faculty who will teach the course Prof. Bhim Singh, Prof. K. R. Rajagopal,Prof. M. Veerachary, Dr. A. K. Jain, Dr. Ramkrishan Maheshwari, Dr. Anandarup Das

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

13.	**Course objectives** *(about 50 words)***:** • To understand the basic principle of power electronics devices and circuits.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** **Experiments on Power electronic converters and their control.**

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

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.

Laboratory manual

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	Yes
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	0
21.2	Open-ended problems	0
21.3	Project-type activity	30%
21.4	Open-ended laboratory work	70%
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Electrical Drives Laboratory**
3.	**L-T-P structure**	**0-0-3**
4.	**Credits**	**1.5**
5.	**Course number**	**ELP 852**
6.	**Status** (*category* for *program*)	PC

7.	**Pre-requisites** (course no./title)	

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem ☐1stsem ☒2ndsem ☐Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh,Prof. K Rajagopal ,Prof. M Veerachary, Prof. G. Bhuvaneswari,Dr. Amit Jain, Dr. Ramkrishan Maheshwari, Dr. Anandarup Das

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

13.	**Course objectives** *(about 50 words)***:** • Laboratory hands on experience for students on electric motor drives

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Experiments on drive systems with converter fed dc and ac drives and their control.

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

Module no.	Topic	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
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.

1. Laboratory Manual

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	Yes
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	0
21.2	Open-ended problems	0
21.3	Project-type activity	30
21.4	Open-ended laboratory work	70
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**DSP Based Control of Power Electronics and Drives Laboratory**
3.	**L-T-P structure**	**0-0-3**
4.	**Credits**	**1.5**
5.	**Course number**	**ELP853**
6.	**Status** (*category* for *program*)	Programe Core

7.	**Pre-requisites** (course no./title)	EEL741, EEL743

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	Not Applicable

10.	**Frequency of offering**	☐Every sem ☐1stsem ☒2ndsem ☐Either sem -

11.	**Faculty who will teach the course** Prof. M. Veerachary, Dr. Amit Kumar jain, Dr. R. K. Maheshwari, Dr. Anandarup Das, Prof.K.R.Rajagopal, Prof. Bhim Singh

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** To train the students in the emerging area DSP based control of Power Electronic and Drive Systems.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Experiments on the DSP/ Digital signal controllers, Interfacing peripherals to DSP, Assembly language programming, Real-time voltage/ current, speed sensing signal and processing, PWM strategies realization through DSP and controlling power electronic and Drive Systems.

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

Module no.	Topic	No. of hours
	Not Applicable	
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.

1.Digital Signal Processing: Steven W Smith
2.Digital Control System Design: Santina, Stubberud, Hostetter
3.DSP based electromechanical motion control: H. A. Toliyat, Steven G. Campbell
4.Modern Control Systems: John A Borrie
5.Switching Power supply design – Abraham I Pressma
6.Fundamental of Power Electronics: Robert Erickson

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

20.1	Software	Existing facilities in terms of software are sufficient
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	Yes
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	0
21.2	Open-ended problems	0
21.3	Project-type activity	30%
21.4	Open-ended laboratory work	70%

21.5	Others (please specify)	0%

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Electrical Machines CAD Laboratory**
3.	**L-T-P structure**	**0-1-4**
4.	**Credits**	**3**
5.	**Course number**	**ELP854**
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	

10.	**Frequency of offering**	☐Every sem ☐1stsem ☐2ndsem ☒Either sem -

11.	**Faculty who will teach the course** Prof. Bhim Singh,Prof. K Rajagopal ,Prof. M. Veerachary, Prof. G. Bhuvaneswari, Dr. Amit Jain, Dr. Ramkrishan Maheshwari, Dr. Anandarup Das

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

13.	**Course objectives** *(about 50 words)***:** • Laboratory hands on experience for students on electric machine design

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Computer aided design of electrical machines.

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

Module no.	Topic	No. of hours
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
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

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. Laboratory Manual

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	Yes
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	0
21.2	Open-ended problems	0
21.3	Project-type activity	30
21.4	Open-ended laboratory work	70
21.5	Others (please specify)	0

Date: (Signature of the Head of the Department)

COURSE TEMPLATE

1.	**Department/Centre proposing the course**	**Electrical Engineering**
2.	**Course Title** *(< 45 characters)*	**Smart-Grids Laboratory**
3.	**L-T-P structure**	**0-1-4**
4.	**Credits**	**3**
5.	**Course number**	**ELP855**
6.	**Status** (*category* for *program*)	PE

7.	**Pre-requisites** (course no./title)	EEL741, EEL743

8.	**Status vis-à-vis other courses** *(give course number/title)*	
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)	Not Applicable

10.	**Frequency of offering**	☐Every sem ☐1stsem ☐2ndsem ☒Either sem -

11.	**Faculty who will teach the course** Prof. M. Veerachary, Dr. Amit Kumar jain, Dr. R. K. Maheshwari, Dr. Anandarup Das, Prof.K.R.Rajagopal, Prof. Bhim Singh

12.	**Will the course require any visiting faculty? (yes/no)**	No

13.	**Course objectives** *(about 50 words)***:** To train the students in the emerging area of Smart-Grids.

14.	**Course contents (about 100 words) (Include laboratory/design activities):** Experiments related to smart-grids measurement and control

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

Module no.	Topic	No. of hours
	Not Applicable	
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

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.

Laboratory manual

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

20.1	Software	Existing facilities in terms of software are sufficient
20.2	Hardware	
20.3	Teaching aides (videos, etc.)	
20.4	Laboratory	Yes
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	0
21.2	Open-ended problems	0
21.3	Project-type activity	30%
21.4	Open-ended laboratory work	70%
21.5	Others (please specify)	0%

Date: (Signature of the Head of the Department)