Course Handout for 4rd Year ELECTRICAL ENGINEERING PROGRAM

Course Title	: Electric Drive
Course Code	: PC EE-701
L-T-P-S Structure	: 3-0-2-0
Credits	: 3,1
Pre-requisite	: 1. Basic Electrical Engineering (ES-EE-101) 2. Electric Machine-I (PC-EE-401) 3. Electric Machine-II(PC-EE-501)
Course Coordinator	: Indrajit Koley
Team of Instructors	: Indrajit Koley & Subhajit Roy
Teaching Associates (For LAB only)	: Niladri Chakraborty & Mousumi Das

Course Objective:

1. To understand basic concept, classification and principle of operation of Electric Drive
2. To understand basic concept, classification and principle of operation of Electric Drive
3. To understand methods of control of speed of DC and AC Drives.
4. To solve problem related to Electric Drive

COURSE OUTCOMES (COs):

CO No.	Course Outcome (CO)	Blooms Taxonomy Level (BTL)	Target %
CO1	explain the principle of operation of Electric Drive	2	65%
CO2	describe different methods of starting and braking of Electric Drive.	3	65%
CO3	model and control DC Drive	4	65%
CO4	control speed of Induction and Synchronous motors.	4	65%
CO5	recommend drives for different applications.	3	65%
CO6	estimate ratings, variables and parameters of Electric Drives.	5	65%

PROGRAM OUTCOMES(POs):

PO Number	Description
1. Engineering Knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

3. **Design/ development of solutions**	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**	Function effectively as an individual, and as a member or leader indiverse teams, and in multidisciplinary settings.
10. **Communication**	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Lifelong learning**	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Mapping of Course Outcomes and Program Outcomes: (Sample Attached)

Course Outcomes	Program Outcomes												PSOs	
	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12	1.	2.
CO1	2	0	0	0	0	0	0	0	0	0	0	2	0	0
CO2	1	1	2	0	2	0	0	1	3	2	0	2	1	2
CO3	2	1	1	0	1	0	0	0	2	1	0	2	1	2
CO4	1	3	1	0	2	0	0	1	2	2	0	2	0	2

CO5	3	1	1	0	1	0	0	1	2	1	0	2	2	1
CO6	2	3	1	0	1	0	0	0	2	0	0	0	2	0
Avg. CO	**1.83**	**1.80**	**1.20**	**0**	**1.40**	**0**	**0**	**1.00**	**2.20**	**1.50**	**0**	**2.00**	**1.50**	**1.75**

1 = courses in which the student will be exposed to a topic
2 = courses in which students will gain competency in that area
3 = courses in which students will master that skill

SYLLABUS:

Unit	Content
1	**Electric Drive:** Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Steady state stability, Transient stability. Multiquadrant operation of drives. Load equalization.
2	**Motor power rating:** Thermal model of motor for heating and cooling, classes of motor duty, determination of motor rating for continuous, short time and intermittent duty, equivalent current, torque and power methods of determination of rating for fluctuating and intermittent loads. Effect of load inertia & environmental factors
3	**Stating of Electric Drives:** Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time, Energy relation during stating. Methods to reduce the Energy loss during starting. Braking of Electric Drives: Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking,
4	**DC motor drives:** Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor DC motor drives: Modeling of DC motors, State space modeling, block diagram & Transfer function, Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. Power factor, supply harmonics and ripple in motor
5	**Induction motor drives:** Stator voltage variation by three phase controllers, Speed control using chopper resistance in the rotor circuit, slip power recovery scheme. Pulse width modulated inverter fed and current source inverter fed induction motor drive. Volts/Hertz Control, Vector or Field oriented control
6	**Synchronous motor drives:** Variable frequency control, Self

	Control, Voltage source inverter fed synchronous motor drive, Vector control.
7	**Introduction to Solar and Battery Powered Drive,** Stepper motor, Switched Reluctance motor drive Industrial application: Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

TEXT BOOKS:

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, TMH
3. A first course on Electrical Drives, S.K. Pillai, , New Age International Publication.

REFERENCE BOOKS:

1. Electric motor drives, R. Krishnan, PHI
2. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
3. Electric Motor & Drives. Austin Hughes, Newnes.

COURSE DELIVERY PLAN:

Week	Sess. No.	CO	Topic (s)	Book No. [CH No.][Page No.]	Teaching-Learning Methods	Planned Date	Execution Date
1	1 & 2	1	Discussion of Course outcome and program outcome, Electric Drive: Concept, classification, parts and advantages of electrical dives. Types of Loads,	A first course on Electrical Drives by S.K.Pillai, Chapter-1, Page- 1-3	T: Chalk & Talk L: Observes understands	04.07.22, 05.07.22	18.07.22
1	3	1	Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and	A first course on Electrical Drives by S.K.Pillai, Chapter-2, Page- 3-33	T: Chalk & Talk L: Observes , understands	08.07.22	19.07.22

			translational motion.				
2	4	2,6	Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion.	A first course on Electrical Drives by S.K.Pillai, Chapter-2, Page- 3-33	**T:** Chalk & Talk L: Observes understands	11.07.22	22.07.22 25.07.22
	5	1,6	Transient stability. Multi quadrant operation of drives.	A first course on Electrical Drives by S.K.Pillai, Chapter-2, Page- 3-33	T: Lecturing L: Observes understands	12.07.22	26.07.22 29.07.22 01.08.22
	6	2,6	Load equalization .	A first course on Electrical Drives by S.K.Pillai, Chapter-2, Page- 3-33	**T:** Chalk & Talk L: Observes understands	15.07.22	02.08.22, 03.08.22, 05.08.22
3	7	2,6	Motor power rating: Thermal model of motor for heating and cooling, classes of motor duty,	A first course on Electrical Drives by S.K.Pillai, Chapter-7, Page- 137-165	T: Chalk & Talk L: Observes , understands	18.07.22	12.08.22

	8	1,6	equivalent current, torque and power methods of determinati on of rating for fluctuating and intermittent loads.	A first course on Electrical Drives by S.K.Pillai, Chapter-7, Page- 137-165	T: Chalk & Talk L: Observes , understands	19.07.22	
	9	1,6	Effect of load inertia & environmen tal factors.	A first course on Electrical Drives by S.K.Pillai, Chapter-7, Page- 137-165	T: Chalk & Talk L: Observes , understands	22.07.22	
4	10	3,4, 6	Stating of Electric Drives: Effect of starting on Power supply	A first course on Electrical Drives by S.K.Pillai, Chapter-6, Page- 89-103	T: Chalk & Talk L: Observes , understands	25.07.22	
	11	3,4, 6	Acceleratio n time, Energy relation during stating.	A first course on Electrical Drives by S.K.Pillai, Chapter-6, Page- 89-103	T: Chalk & Talk L: Observes , understands	26.07.22	
	12	3,4, 6	Methods to reduce the Energy loss during starting.	A first course on Electrical Drives by S.K.Pillai, Chapter-6, Page- 89-103	T: Chalk & Talk L: Observes , understands	29.07.22	
5	13	3,4, 6	Braking of Electric	A first course on Electrical Drives by S.K.Pillai, Chapter-7,	**T:** Chalk & Talk L: Observes	01.08.22	

			Drives: Types of braking, braking of DC motor,	Page-107-137	understands		
	14	3,6	Induction motor and Synchronous motor,	A first course on Electrical Drives by S.K.Pillai, Chapter-7, Page-107-137	**T:** Chalk & Talk L: Observes understands, Problem solving	02.08.22	
	15	4,6	Energy loss during braking,	A first course on Electrical Drives by S.K.Pillai, Chapter-7, Page-107-137	**T:** Chalk & Talk L: Observes understands	05.08.22	
6	*16*	3,6	DC motor drives: Modeling of DC motors, State space modeling,	A first course on Electrical Drives by S.K.Pillai, Chapter-3, Page-33-62	**T:** Chalk & Talk L: Observes understands	08.08.22	
	17	3,4, 6	block diagram & Transfer function,	A first course on Electrical Drives by S.K.Pillai, Chapter-3, Page-33-62	T: Lecturing L: Observes understands	12.08.22	
	18	3,4, 6	Single phase, three phases fully controlled and half controlled DC drives.	A first course on Electrical Drives by S.K.Pillai, Chapter-8, Page-165-193	**T:** Chalk & Talk L: Observes understands	16.08.22	
7	*19*	4,6	Dual converter control of DC drives.	A first course on Electrical Drives by S.K.Pillai, Chapter-8, Page-165-193	**T:** Chalk & Talk L: Observes understands	19.08.22	

	20	3,6	Power factor, supply harmonics and ripple in motor	A first course on Electrical Drives by S.K.Pillai, Chapter-8, Page-165-193	T: Lecturing L: Observes understands	22.08.22	
	21	3,6	current. Chopper controlled DC motor drives	A first course on Electrical Drives by S.K.Pillai, Chapter-8, Page-165-193	T: Chalk & Talk L: Observes , understands	29.08.22	
8	22	3,6	Closed loop control of DC Drives.	A first course on Electrical Drives by S.K.Pillai, Chapter-8, Page-165-193	T: Chalk & Talk L: Observes , understands	30.08.22	
	23	3,4, 6	Induction motor drives: Stator voltage variation by three phase controllers,	A first course on Electrical Drives by S.K.Pillai, Chapter-8, Page-165-193	T: Lecturing L: Observes understands	02.09.22	
	24	3,4, 6	Speed control using chopper resistance in the rotor circuit,	Fundamentals of Electric Drives by G. K. Dubey: Chapter-5, page-87	T: Chalk & Talk L: Observes understands	12.09.22	
9	25	3,4, 6	slip power recovery scheme.	Fundamentals of Electric Drives by G. K. Dubey: Chapter-6, page-218	T: Chalk & Talk L: Observes understands	13.09.22	
	26	4,6	Pulse width modulated inverter fed and	Fundamentals of Electric Drives by G. K. Dubey: Chapter-6, page-191-209	T: Chalk & Talk L: Observes understands	16.09.22	

			current source inverter fed induction motor drive.				
	27	5	Volts/Hertz Control, Vector or Field oriented control.	Fundamentals of Electric Drives by G. K. Dubey: Chapter-6, page-186-190	T: Chalk & Talk L: Observes understands	19.09.22	
10	28	5	Synchronous motor drives: Variable frequency control,	Fundamentals of Electric Drives by G. K. Dubey: Chapter-7, page-257	T: Chalk & Talk L: Observes understands	20.09.22	
	29	5	Self Control,	Fundamentals of Electric Drives by G. K. Dubey: Chapter-7, page-260	T: Chalk & Talk L: Observes understands	23.09.22	
	30	3,6	Voltage source inverter fed synchronous motor drive,	Fundamentals of Electric Drives by G. K. Dubey: Chapter-7, page-269	T: Chalk & Talk L: Observes understands	26.09.22	
11	31	3,6	Introduction to Solar and Battery Powered Drive,	Fundamentals of Electric Drives by G. K. Dubey: Chapter-9, page-297-304	T: Chalk & Talk L: Observes , understands	27.09.22	
	32	3,6	Stepper motor, Switched Reluctance motor drive	Fundamentals of Electric Drives by G. K. Dubey: Chapter-6, page-280-294	T: Lecturing L: Observes understands	30.09.22	

	33	3,4, 6	Industrial application: Drive consideratio n for Textile mills,	Fundamentals of Electric Drives by G. K. Dubey: Chapter-7, page-365	T: Lecturing L: Observes understands	07.10.22	
12	34	3,4, 6	Steel rolling mills, Cement mills, Paper mills,	A first course on Electrical Drives by S.K.Pillai, Chapter-10, Page-203-229	T: Lecturing L: Observes understands	10.10.22	
	35	3	Machine tools. Cranes & hoist drives.	A first course on Electrical Drives by S.K.Pillai, Chapter-10, Page-203-229	T: Chalk & Talk L: Observes understands	11.10.22	

COURSE TIME TABLE

Theory		Lab	
DAYS	TIMING	DAYS	TIMING
Monday	12:30 pm-01:20 pm	*Tuesday*	10:10 am-11:40 am (Group 2)
Thursday	10:50 am-11:40 am		
Friday	02:10 pm-03:00 pm	*Wednesday*	10:00 am-11:40 am (Group 1)

REMEDIAL CLASSES:

Supplement course handout, which may perhaps include special lectures and discussions that would be planned, and schedule notified accordingly.

DELIVERY DETAILS OF CONTENT BEYOND SYLLABUS:

Content beyond syllabus covered (if any) should be delivered to all students that would be planned, and schedule notified accordingly.

S.No	Advanced Topics, Additional Reading, Research papers and any	CO	References/MOOCS
1	Fundamental of Electric Drives	CO1-CO6	https://archive.nptel.ac.in/courses/108/104/108104140/

EVALUATION: AS PER MAKAUT GUIDELINES

Schedule for Continuous Assessment (CA):

CA	Assessment By	Schedule
CA-I	Presentation, Quiz, Group Discussion	As per Academic Calendar
CA-II	Report writing	
CA-III	Class test in pen and paper mode to be conducted at the College Level	
CA-IV	Centralized online test to be arranged by the University	
PCA1	Rubrics based Evaluation and Viva -Voce	
PCA2	Rubrics based Evaluation and Viva -Voce	

ATTENDANCE POLICY

Every student is expected to be responsible for regularity of his/her attendance in class rooms and laboratories, to appear in scheduled tests and examinations and fulfil all other tasks assigned to him/her in every course. For Promotion, a Minimum of 50% of internal marks must be obtained. In every course, student has to maintain a minimum of 75% attendance to be eligible for appearing in Semester end examination of the course, for cases of medical issues and other unavoidable circumstances the students will be condoned if their attendance is between 60% to 75% in every course, subjected to submission of medical certificates, medical case file and other needful documental proof to the concerned departments.

DETENTION POLICY

In any course, a student has to maintain a minimum of 75% attendance and must secure a minimum of 50% marks in In-Semester Examinations to be eligible for appearing to the Semester End Examination, failing to fulfill these conditions will deem such student to have been detained in that course.

PLAGIARISM POLICY

Use of unfair means in any of the evaluation components will be dealt with strictly, and the case will be reported to the examination committee.

COURSE TEAM MEMBERS, CHAMBER CONSULTATION HOURS AND CHAMBER VENUE DETAILS:

Each instructor will specify his / her chamber consultation hours during which the student can contact him / her in his / her chamber for consultation.

S.No.	Name of Faculty	Chamber Consultation Day (s)	Chamber Consultation Timings for each day	Chamber Consultation Room No:	Signature of Course faculty
1.	Indrajit Koley	Wednesday	2.10 pm – 4.40 pm	M-013	
		Friday	10.50 am – 1.20 pm		
2	Subhajit Roy	Wednesday	2.10 pm – 4.40 pm	M-013	
		Friday	10.50 am – 1.20 pm		

ATTENDANCE POLICY

Every student is expected to be responsible for regularity of his/her attendance in class rooms and laboratories, to appear in scheduled tests and examinations and fulfil all other tasks assigned to him/her in every course. For Promotion, a Minimum of 50% of internal marks must be obtained. In every course, student has to maintain a minimum of 75% attendance to be eligible for appearing in Semester end examination of the course, for cases of medical issues and other unavoidable circumstances the students will be condoned if their attendance is between 60% to 75% in every course, subjected to submission of medical certificates, medical case file and other needful documental proof to the concerned departments.

DETENTION POLICY

In any course, a student has to maintain a minimum of 75% attendance and must secure a minimum of 50% marks in In-Semester Examinations to be eligible for appearing to the Semester End Examination, failing to fulfill these conditions will deem such student to have been detained in that course.

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GENERAL INSTRUCTIONS

Students should come prepared for classes and carry the text book(s) or material(s) as prescribed by the Course Faculty to the class.

NOTICES

All notices will be communicated through the institution email.
All notices concerning the course will be displayed on the respective Notice Boards.

Signature of COURSE COORDINATOR:

HEAD OF DEPARTMENT:

Head of the Department
Dept. of Electrical Engg.
Siliguri Institute of Technology

29/08/22

Approval from: Head of the Institutions
(Sign with Office Seal)

Principal
Siliguri Institute of Technology