



UTILIZATION OF ELECTRICAL ENERGY

Subject Code : A70232
Regulations : R15 - JNTUH
Class : IV Year B.Tech EEE I Semester



Department of Electrical and Electronics and Engineering

BHARAT INSTITUTE OF ENGINEERING AND TECHNOLOGY

Ibrahimpattanam - 501 510, Hyderabad

UTILIZATION OF ELECTRICAL ENERGY (A70232)

COURSE PLANNER

COURSE OVERVIEW

This course primarily deals with utilization of electrical energy generated from various sources. It is important to understand the technical reasons behind selection of motors for electric drives based on the characteristics of loads. Electric heating, welding and illumination are some important loads in the industry in addition to motor/drives. Another major share of loads is taken by Electric Traction. Utilization of electrical energy in all the



above loads is discussed in detail in this course. Demand side management concepts are also introduced as a part of this course

PRE REQUISITES:

The knowledge of following subjects is essential to understand the subject:

1. Electrical Machines
2. Power Electronics and Drives
3. Power Systems –II

COURSE OBJECTIVE:

1	This Course provides an introduction to the principles of electrical drives and their applications in daily life.
2	This course deals with the fundamentals of illumination and its classification.
3	Provides knowledge on electrical traction systems

COURSE OUTCOMES:

At the end of the course the student will be in a position to

S.No	Description	Bloom's Taxonomy Level
1	To understand the operating principles and characteristics of traction motors with respect to speed, temperature, loading condition	Remembering, evaluating (level1,level V)
2	To acquaint with the different types of heating and welding techniques	Understanding ,level-2
3	To study the basic principles of illumination and its measurement	Understanding, level-2
4	To understand the basic principle of electric traction including speed–time curves of different traction services	Understanding,evaluating (level-1,level-5)
5	To understand the method of calculation of various traction system for braking, acceleration and other related parameters, including demand side management.	Understanding, level-2

HOW PROGRAM OUTCOMES ARE ASSESSED

Program Outcomes		Level	Proficiency assed by
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	3	Assignments, Mock tests
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering	1	Assignments, Mock tests



	sciences.		
PO3	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.	2	Assignments, Mock tests
PO4	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.	-	Assignments, Mock tests
PO5	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.	1	Assignments, Mock tests
PO6	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.	-	Assignments, Mock tests
PO7	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.	-	-
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	-	-
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	-	-
PO10	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.	-	-



PO11	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.	1	seminars
PO12	Life-long 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.	2	Industrial visits

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED

Program Specific Outcomes		Level	Proficiency assed by
PSO 1	Talented to analyze, design and implement electrical & electronics systems and deal with the rapid pace of industrial innovations and developments	1	Industrial visits, projects
PSO 2	Skillful to use application and control techniques for research and advanced studies in Electrical and Electronics engineering domain	1	Guest lecturers projects

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) - : None

COURSE CONTENT:

JNTUH SYLLABUS

UNIT – I

ELECTRIC DRIVES

Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization.

UNIT II

ELECTRIC HEATING & ELECTRIC WELDING

Advantages and methods of electric heating, resistance heating, induction heating, and dielectric heating. Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

UNIT – III

ILLUMINATION

Introduction, terms used in illumination, laws of illumination, polar curves, photometry, integrating sphere, sources of light. Discharge lamps, MV and SV lamps comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood lighting.

UNIT –IV

ELECTRIC TRACTION – I



System of electric traction and track electrification. Review of existing electric traction systems in India. Special features of traction motor, methods of electric braking – plugging, rheostatic braking and regenerative braking. Mechanics of train movement. Speed-time curves for different services – trapezoidal and quadrilateral speed time curves.

UNIT – V

ELECTRIC TRACTION – II

Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and braking retardation adhesive weight and coefficient of adhesion.

.GATE SYLLABUS: NOT APPLICABLE

IES SYLLABUS: NOT APPLICABLE

TEXT BOOKS:

1. Utilization of Electrical Energy - by E. Openshaw Taylor, University Press.
2. Art & Science of Utilization of Electrical Energy - by Par tab, Dhanpat Ravi & Sons.

REFERENCE BOOKS:

3. Utilization of Electrical Power including Electric drives and Electric traction – by N.V. Suryanarayana, New Age International (P) Limited, Publishers, 1996.
4. Generation, Distribution and Utilization of Electrical Energy - by C.L. Wadhwa New Age International (P) Limited, Publishers, 1997.

LESSON PLAN-COURSE SCHEDULE:

Lecture No.	Week No.	TOPIC	Course Learning outcomes	Reference
UNIT – 1				
1.	1	Basic of Electric Drives & Type of Electric Drives	Recall Drives	T1,R 1
2.		Choice of motors, starting & running characteristics	Understanding characteristics	
3.		Speed Control & Temp Rise of motor	Compare Speed & Temp	
4.		Applications of electric drives	Understanding the Applications	
5.	2	Types of Industrial loads	Analyzing Types of loads	
6.		Continuous & variable loads	Analyzing Types of loads	
7.		Load equalization	Analyzing Types of loads	
8.		Load equalization	Analyzing Types of loads	
9.	3	Numerical problems	Solving	
10.		Numerical problems	Solving	
11.		Review of Unit-I		



12.		Mock Test – I		
UNIT – 2				
13.	4	Basic of Electric Heating	Understanding Heating	T1,R 1
14.		Methods of Electric Heating	Inspect Methods of Heating	
15.		Advantages of Electric Heating	Understanding Advantages	
16.		Resistance Heating	Compare Methods of Heating	
		<i>Tutorial / Bridge Class # 1</i>		
17.	5	Induction Heating	Understanding Induction Heating	
18.		Dielectric Heating	Understanding Dielectric Heating	
19.		Numerical problems	Solving	
20.		Electric Welding	Understanding Electric Welding	
		<i>Tutorial / Bridge Class # 2</i>		
21.	6	Resistance & arc Welding	Understanding types of Welding	
22.		Electric Welding Equipment	Knowledge about Welding Equipment	
23.		A.C. & D.C. Welding	Compare Methods of Welding	
24.		Revision		
		<i>Tutorial / Bridge Class # 3</i>		
UNIT – 3				
25.	7	Fundamentals of illumination	Understanding the Fundamentals	T1,R 1
26.		Terms used in illumination	Knowledge about illumination	
27.		Laws of illumination	Analyzing Laws	
28.		Problems	Solving	
		<i>Tutorial / Bridge Class # 4</i>		
29.	8	Polar curves	Knowledge about curves	
30.		Photometry	Knowledge about Photometry	



31.		Integrating sphere	Understanding	
32.		Sources of light	Knowledge	
		<i>Tutorial / Bridge Class # 5</i>		
I Mid Examinations (Week 9)				
UNIT – 3 Contd.				
33.	10	Discharge lamps , MV Lamps	Knowledge about various Lamps	T1,R 1
34.		SV Lamps , Tungsten filament	Knowledge about various Lamps	
35.		Fluorescent tubes ,Light control	Knowledge about various Lamps	
36.		Lighting design ,Flood lighting	Knowledge about various Lamps	
		<i>Tutorial / Bridge Class # 6</i>		
UNIT – 4				
37.	11	System of Elec. traction	Understanding traction	T1,R 1
38.		Track electrification	Analyzing electrification	
39.		Track Electrification India Problems	Analyzing electrification	
40.		Traction motor features	Knowledge about Traction	
		<i>Tutorial / Bridge Class # 7</i>		
41.	12	Electric breaking	Knowledge about breaking	T1,R 1
42.		Review problems	Solving	
43.		Mechanics of train movement	Understanding Mechanism	
44.		Speed-time curves	Analyzing curves	
		<i>Tutorial / Bridge Class # 8</i>		
45.	13	Trapezoidal speed-time curves	Analyzing curves	T1,R 1
46.		Quadrilateral speed-time curves	Analyzing curves	
47.		Problems	Solving	
48.		Revision		
		<i>Mock Test - II</i>		
UNIT – 5				
49.	14	Tractive effort calculations	Understanding	



			Tractive effort	T1,R 1
50.		Power calculations	Solving	
51.		Power calculations	Solving	
52.		Effects of varying acceleration	Knowledge about acceleration	
		<i>Tutorial / Bridge Class # 9</i>		
53.	15	Breaking retardation	Knowledge about Breaking retardation	
54.		Breaking retardation		
55.		Breaking retardation		
56.		Adhesive weight		
		<i>Tutorial / Bridge Class # 10</i>		
57.	16	Adhesive weight	Solving Various problems	
58.		Problems		
59.		problems		
60.		Problems		
		<i>Topics beyond the syllabus#11</i>		
61.	17	Electrical hazards in mines	Giving Knowledge about various concepts in utilization	
62.		Applications of refrigeration		
63.		Economical aspects		
64.		ECONOMIC ASPECTS OF UTILISING ELECTRICAL ENERGY		
		<i>Tutorial / Bridge Class # 12</i>		
II Mid Examinations (Week 18)				

IX. MAPPING COURSE OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Outcomes	Program Outcomes (PO)												Program Specific Outcomes (PSO)	
	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
C O1		-	1	1	-	1	-	-	-	-	-	-	2	1
C O2	2	1	1	1	-	1	-	-	-	-	-	-	2	2
C O3	2	1	2	1	-	1	-	-	-	-	-	-	1	2
C O4	2	2	1	1	1	1	-	-	-	-	-	-	1	2
C O5	3	2	2	2	2	2	-	-	-	-	-	-	1	2



Av g	1.8	1. 2	1.4	1.2	0.6	1.2	-	-	-	-	-	-	1.4	1.8
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1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) -: None

QUESTION BANK: (As Per JNTU, Hyderabad)

DESCRIPTIVE QUESTIONS:

UNIT-I

LONG ANSWER QUESTIONS

S.NO	QUESTION	BLOOMS TAXANOMY LEVEL	COURSE OUTCOME
1	Discuss the advantages and disadvantages of electric drive over other drives.	knowledge	1
2	Explain in detail the general consideration in selecting motor power ratings	understand	1
3	What are the advantages of equipment operated from high frequency supply??	understand	1
4	What is meant by load equalization? Derive the expression for instantaneous motor torque, M.O.I of the fly wheel and the motor slip. State any assumptions mad	knowledge	1
5	Discuss the terms 'continuous', 'intermittent' and 'variable' loads with example	understand	1

SHORT ANSWER QUESTIONS

S.No	Question	Blooms Taxanomy Level	Course Outcome
1	Distinguish between continuous, Intermittent and variable loads	knowledge	1
2	"If a high degree of speed control is required, d.c. is preferable to a.c. for an electric drive" -Justify.	knowledge	1
3	What are the factors governing the selection of motors?	knowledge	1
4	List the advantages and disadvantages of electric drive over other drives.	knowledge	1
5	Explain various characteristics to be considered for selection of electric drive	knowledge	1

UNIT-II

LONGANSWER QUESTIONS

S.No	Questions	Blooms Taxanomy Level	Course Outcome
1	Explain in brief how heating is done in the following cases: i) Resistance heating, ii) Induction heating iii)		2



	Dielectric heating.	knowledge	
2	Explain the principal of dielectric heating also write advantages and its applications.	knowledge	2
3	Explain in detail about resistance and arc welding.	understanding	2
4	Describe the construction and principle of working of an induction furnace.	understanding	2
5	Describe with neat sketches various methods of electric resistance welding. Give its merits and demerits with respect to arc welding	knowledge	2
6	With a neat sketch explain the working principle of core type and coreless type induction furnace	understanding	2

SHORT ANSWER QUESTIONS

S.No	Questions	Blooms Taxonomy Level	Course Outcome
1	Give some applications of induction heating.	understanding	2
2	Explain about dielectric heating.	knowledge	2
3	List out the properties of heating element.	understanding	2
4	What is the difference between plastic welding & fusion welding?	knowledge	2
5	Give the classification of electric heating methods.	knowledge	2

UNIT-III

LONG ANSWER QUESTIONS:

S.No	Questions	Blooms Taxonomy Level	Course Outcome
1	Explain the following terms w.r.t illumination Engineering: i)Reduction factor ii)Utilization factor iii)Maintenance factor iv)Absorption factor	knowledge	3
2	Explain the construction and working of Sodium vapor lamp.	knowledge	3
3	State and explain laws of illumination	understanding	3
4	Describe the construction and working principal of mercury vapour lamp.	understanding	3
5	Explain the different measurement techniques used for luminous intensity	knowledge	3
6	Explain how will you measure the candle power of a source of light?	understanding	3
7	A lamp giving 300 C.P in all directions below horizontal is suspended 2m above the centre of a square table of 1m side. Calculate the maximum and minimum illumination on the surface of the table	knowledge	3
8	What is photometry? Explain photovoltaic method of	understanding	3



	photometry		
9	A lamp with mean spherical candle power of 1000 is suspended at a height of 1.2m. Determine i) total flux emitted by the lamp ii) the illumination just below the lamp	knowledge	3

SHORT ANSWER QUESTIONS

S.No	Questions	Blooms Taxonomy Level	Course Outcome
1	Define Luminous flux.	knowledge	3
2	Define Solid angle and Space height ratio with respect to illumination.	knowledge	3
3	Define (i) waste light factor (ii) depreciation factor (iii) coefficient of utilization.	knowledge	3
4	Define: Mean spherical Candlepower,	knowledge	3
5	What are the advantages of coiled coil filament gas filled lamp?	knowledge	3

UNIT IV

LONG ANSWER QUESTIONS

S.No	Questions	Blooms Taxonomy Level	Course Outcome
1	From the simplified speed- time curve, determine the maximum speed, when the actual time of run, values of acceleration, retardation and the distance between stops are given.	understanding	4
2	An electric train is to have acceleration and breaking retardation of 0.8 Km/h/s and 3.2 Km/h/s respectively. If the ratio of maximum to average speed is 1.3 and time for stops 26 seconds, find schedule speed for a run of 1.5 km. Assume simplified trapezoidal speed-time curve	knowledge	4
3	For a quadrilateral speed-time curve of an electric train, derive expression for the distance between stops and speed at the end of the coasting period	understanding	4
5	Discuss the main features of various train services. What type of train services corresponds to trapezoidal and quadrilateral speed time curves?	understanding	4
6	What is specific energy consumption of a train? Explain various factors affecting it.	understanding	4
7	A suburban train runs with an average speed of 36 kmph between two stations 1.8 km apart. The values of acceleration and retardation are 1.8 kmph/s and 3.6 kmph/s. Calculate the maximum speed of the	knowledge	4



	train assuming trapezoidal speed-time curve		
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SHORT ANSWER QUESTIONS

S.No	Questions	Blooms Taxonomy Level	Course Outcome
1	What is braking retardation?	knowledge	4
2	Define (i) Average speed, (ii) crest speed, (iii) scheduled speed.	knowledge	4
3	Why a series motor is preferred for the electric traction.	knowledge	4
4	What are the disadvantages of diesel electric traction?	knowledge	4
5	Define tractive effort.	knowledge	4

UNIT V

LONG ANSWER QUESTIONS

S.No	Questions	Blooms Taxonomy Level	Course Outcome
1	Briefly explain the a.c. motors used in traction	understanding	5
2	Show that if the speed-time curves are similar, Specific	understanding	5
3	State the factors that affect the specific energy consumption and their influence on it.	knowledge	5

SHORT ANSWER QUESTIONS

S.NO	QUESTIONS	BLOOMS TAXANOMY LEVEL	COURSE OUTCOME
1	What are the advantages of electric braking over mechanical braking	knowledge	5
2	Define Dead weight, Accelerating weight, Adhesive weight	knowledge	5
3	What are the different systems of track electrification	knowledge	5
4	Where will you recommend the hybrid drive	knowledge	5
5	What are the various current collective systems	knowledge	5

OBJECTIVE QUESTIONS: As Per JNTU, Hyderabad

UNIT-1

- The consideration involved in the selection of the type of electric drive for a particular application depends on
 - Speed control range and its nature
 - Starting torque
 - Environmental conditions
 - All of the above.
- Which of the following is preferred for automatic drives?
 - Synchronous motors
 - Squirrel cage induction motor
 - Ward Leonard controlled dc motors
 - Any of the above.



3. Which type of drive can be used for hoisting machinery
 - a) AC slip ring motor
 - b) Ward Leonard controlled DC shunt motor
 - c) DC compound motor
 - d) Any of the above.
4. The motor normally used for crane travel is
 - a) AC slip ring motor
 - b) Ward Leonard controlled DC shunt motor
 - c) Synchronous motor
 - d) DC differentially compound motor.
5. A wound rotor induction motor is preferred over squirrel cage induction motor when the major consideration involved is
 - a) High starting torque
 - b) Low starting current
 - c) Speed control over limited range
 - b) All of the above.
6. A synchronous motor is found to be more economical when the load is above
 - a) 1 kW
 - b) 10 kW
 - c) 20 kW
 - d) 100kW.

UNIT-2

1. Which of the following joint have high corrosion resistance?
 - a) Welding joint
 - b) Riveted joint
 - c) Bolted joint
 - d) None of the above
2. Which of the following ray is not produced during welding?
 - a) Gamma ray
 - b) Visible light rays
 - c) Infrared ray
 - d) Ultra violet rays
3. Single-V and single-U butt welds are used for sheets of thickness:
 - a) upto 10mm
 - b) 5-15mm
 - c) 10-20mm
 - d) 15-25mm
4. Double-V and double-U butt welds are used for plates of thickness
 - a) 1-5mm
 - b) 5-10mm
 - c) 10-15mm
 - d) Over 15mm
5. Which of the following types is not fillet weld?
 - a) butt joint
 - b) lap joint
 - c) T-joint
 - d) Corner joint
6. Which of the following is an example of plastic welding?
 - a) Gas welding
 - b) Arc welding
 - c) Forge welding
 - d) Thermit welding

UNIT-3

1. Radiant efficiency of the luminous source depends on
 - a) Shape of the source
 - b) Temperature of the source
 - c) Wavelength of light rays
 - d) All of the above.
2. Light waves travel with a velocity of
 - a) 3×10^{10} cm/s
 - b) 3×10^{12} cm/s
 - c) 3×10^{15} cm/s
 - d) 3×10^{18} cm/s.
3. Carbon arc lamps are commonly used in
 - a) Domestic lighting
 - b) Street lighting
 - c) Cinema projectors
 - d) Photography.
4. The unit of solid angle is
 - a) Solid angle
 - b) Radian
 - c) Steradian
 - d) Candela.
5. Candela is the unit of
 - a) Luminous flux
 - b) Luminous intensity
 - c) Wavelength
 - d) None of the above.
6. The unit of luminous flux is



- a) Steradian b) Candela c) Lumen d) Lux.

UNIT -4

1. Overall efficiency of steam locomotive system is close to
a) 5 to 10% b) 25 to 30% c) 55 to 60% d) 75 to 80%.
2. In a steam locomotive electric power is provided through
a) Battery system b) Diesel engine generator c) Overhead wire d) Small turbo generator.
3. Maximum horse power of steam locomotive is
a) 100 b) 500 c) 1500 d) 2500.
4. The pressure of steam in a locomotive is
a) 10-15 kg/sq. cm b) 20 - 30 kg/sq. cm c) 40 - 50 kg/sq. cm d) 80 - 90 kg/sq. cm
5. The efficiency of diesel locomotives is nearly
a) 20 - 25 percent b) 35 - 40 percent c) 50 - 55 percent d) 70 - 75 percent.
6. The advantage of electric traction over other methods is
a) No pollution problems b) Faster acceleration c) Better braking action d) All of the above.

UNIT -5

1. Long distance railways use
a) 200 V DC b) 25 kV Single phase AC c) 25 kV Two phase AC d) 25 kV Three phase AC.
2. The range of horsepower for diesel locomotives is
a) 100 to 500 b) 500 to 1000 c) 1500 to 2500 d) 4000 to 5500.
3. Steam Engine provided on steam locomotives is
a) Single acting condensing type b) Double acting condensing type c) Double acting non - condensing type d) Single acting non condensing type.
4. A submarine while moving under water, is provided driving power through
a) Diesel engines b) Steam turbine c) Gas turbine d) Batteries.
5. Overload capacity of diesel engines is usually restricted to
a) 2 % b) 10% c) 25% d) 50%.
6. Which locomotive has the highest operational availability?
a) Diesel b) Electric c) Steam d) All have same availability.

GATE: Not Applicable

ESE: Not Applicable

LIST OF JOURNALS:

1. Electric Traction Systems

URL: http://www.theiet.org/resources/conferences/transport/elec_trac.cfm

2. Electric Traction - Motive Power and Energy Supply: Basics and Practical

URL:

<https://books.google.co.in/books?id=Hdvr82d23mkC&pg=PR5&lpg=PR5&dq=lecture+on+electric+traction&source=bl&ots=ssz60GTWMf&sig=GiM2W1L44cLV8GEHLFBLI>



mtRLRU&hl=en&sa=X&ved=0ahUKEwjak6XPtIbNAhXLMo8KHXSFCycQ6AEIKzA
D#v=onepage&q=lecture%20on%20electric%20traction&f=false

3. Electric Power Systems Research
URL: <http://www.journals.elsevier.com/electric-power-systems-research/>
4. International Journal of Electrical Power & Energy Systems
URL: <http://www.journals.elsevier.com/international-journal-of-electrical-power-and-energy-systems/>
5. IEEE Proceedings of the IEE - Part IA: Electric Railway Traction
URL: <http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=5239454>
6. IEEE Power Engineering Journal
RL: <http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?punumber=2224>

WEBSITES:

1. Illumination engineering and electric utility services.
URL: <http://nptel.ac.in/courses/108105060/>
2. Centre for Railways Research at IIT Kharagpur.
3. Nptel.ac.in/courses/108105058/
4. Nptel.ac.in/courses/108105060/