CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET402	ELECTRICAL SYSTEM DESIGN AND ESTIMATION	PCC	2	1	0	3

Preamble: Electrical System Design would provide general awareness on IS Product standards / Codes of Practice, The Electricity Act 2003, CEA Regulations and Rules, NEC etc. related to Domestic, Industrial and Commercial Installations. It will also help in the design of Main and Sub Switchboards and distribution system for a medium class domestic and industrial electrical installations. Design of lighting system and selection of luminaries. Selection of Underground cables, Standby generators, lifts and with all involved auxiliaries. Design and selection of power distribution system with power and motor loads for a medium industry. Electrical system design for High-rise buildings with rising main/ cable distribution to upper floors including fire pumps. Design of indoor and outdoor 11kV substations including selection of switching and protective devices for an HT consumer. Essential safety requirements for the electrical installations for Recreational buildings.

Prerequisite: Basics of electrical power systems, circuit analysis and fault level calculations.

Course Outcomes: After the completion of the course the student will be able to:

CO 1	Explain the rules and regulations in the design of components for medium and high voltage installations.
CO 2	Design lighting schemes for indoor and outdoor applications.
CO 3	Design low/medium voltage domestic and industrial electrical installations.
CO 4	Design, testing and commissioning of 11 kV transformer substation.
CO 5	Design electrical installations in high rise buildings.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	1	2	-	-	1	-	2	-	-	-	-
CO 2	3	2	3	-	-	1	1	1	-	-	-	1
CO 3	3	1	3	-	-	1	-	1	-	-	-	1
CO 4	3	1	3	-	-	1	-	1	-	-	1	1
CO 5	3	1	3	-	-	1	1	1	-	-	-	1

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember (K1)	10	10	20
Understand (K2)	15	15	30
Apply (K3)	25	25	50
Analyse (K4)			
Evaluate (K5)			
Create (K6)			

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:

Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Case study/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contains 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):
1. Mention the Scope of The Electricity Act 2003 (K1, K2, PO1)
2. Precautions to be followed for electric safety against loss of life and materials (K3, PO2, PO3, PO6)
3. Mention the Scope of IS 732 (K2, PO8)

Course Outcome 2 (CO2)
1. How are the luminaries selected based on the area of application? (K2, PO3, PO3, PO6)
2. What is CRI? (K1, PO1)
3. Parameters taken into consideration while designing street lighting and flood lighting (K3, PO2, PO3, PO7, PO8, PO12)

Course Outcome 3 (CO3):
1. Characteristics of MCBs (K1, PO1, PO3)
2. Grading between MCBs (K2, PO2, PO6, PO8)
3. Electrical Schematic and physical layout drawings of switch boards, DBs, lighting fittings, fans etc.(K3, PO2, PO6, PO8, P12)

Course Outcome 4 (CO4):
1. Selection of transformer substation. (K1, K2, PO1, PO3)
2. Protective switchgear selection and design of earthing. (K3, PO2, PO6, PO8, PO11)
3. Pre-commission tests to be conducted (K3, PO6, PO12)

Course Outcome 5 (CO5):
1. Selection of different electrical components/systems for multi-storeyed buildings (K1, K2, PO1)
2. Fire protection in high rise buildings (K1, K2, PO2, PO6, PO8)
3. The energy conservation techniques (K2, K3, PO2, PO6)

4. PV solar system design (K3, PO3, PO6, PO7, PO12)
5. Functioning of AMF system (K2, PO1)

Model Question Paper

PAGES: 3

QP CODE:

Reg. No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
EIGHTH SEMESTER B. TECH DEGREE EXAMINATION
MONTH & YEAR

Course Code**: EET402**

Course Name: **ELECTRICAL SYSTEM DESIGN AND ESTIMATION**

Max. Marks: 100 **Duration: 3 Hours**

PART A
Answer all Questions. Each question carries 3 Marks

1	Describe the scope of NEC with regard to electrical system design.
2	What are the 3 phase AC system voltages as per NEC and their permissible limits.
3	Explain the specific design considerations in the design of a good lighting scheme.
4	List the different types of lamps suitable for street lighting and give their merits and demerits.
5	What is load survey and explain its importance in electrical system design.
6	Explain the salient aspects considered for the selection of LV/MV cables.
7	Explain the working principle of MCB/MCCB and compare MCB and MCCB.
8	List out the pre-commissioning tests of 11kV indoor substation of an HT consumer and explain any one method.
9	Explain the terms Continuous, Prime and Standby power ratings as applied to a Diesel Generator set.
10	Explain the principle of operation of an AMF panel in an electrical system. What is its necessity in an industry?

PART B
Answer any one full question from each module. Each question carries 14 Marks

Module 1

11	a	What is standardization, how does NEC assist for the electrical system design.	(5)
	b	Explain the relevance of the following IS codes: IS 732, IS 3043.	(5)
	c	Briefly explain the electrical services in buildings.	(4)
12	a	Enumerate any five safety measures incorporated in system design.	(5)
	b)	Draw the standard graphical symbols as given in NEC for: i) circuit breaker ii) star-delta starter iii) fuse disconnector iv) autotransformer v) energy meter	(5)

c Explain the scope of the Electricity Act 2003. (4)

Module 2

13 a) What are the requirements to be satisfied for good road lighting? How are sources selected for road lighting? (7)

b) An office room of size 9X15m is to be illuminated by 2x18W LED luminaire. The lamps are being mounted at a height of 3m from the work plane. The average illumination required is 240 lux. Calculate the number of lamps required to be fitted, assuming a CU of 0.75 and a LLF of 0.8. Assume the ceiling height of the room as 5m. Draw the layout of the luminaire arrangement. The lumen output of 2x18W LED may be taken as 4000 lumens. (7)

14 a Briefly explain the working of an LED lamp with circuit diagram. (7)

b) Design a road way lighting scheme and determine the spacing between the poles using the given lamps. Which alternative you will choose, from the point of energy conservation?

Width of the road way = 12 m
Illumination required = 15lux
Mounting height of poles = 9 m
Arm length = 2m

Types of Lamps	CU	LLF
HPSV - 150 W, 16000 lumen	0.65	0.7
LPSV - 150 W, 25500 lumen	0.5	0.9

The lamps are placed on one side of the road. Assume any missing data. (7)

Module 3

15 a) List the pre-commissioning tests for domestic installation and with the help of schematic diagram explain any one test in detail. (4)

b) Determine the total connected load, number of sub circuits and type of supply for a domestic building with the following rooms: One-bedroom with attached toilet, hall and kitchen (1BHK). Draw the schematic diagram showing the ratings of MCBs and sub circuits. Design shall be based on the NEC guide lines. Assume all required data. (10)

16 a Briey explain the working of ELCB with a neat connection diagram. (4)

b) A rest house has four air-conditioned bed rooms with attached toilets, dining hall and kitchen. Prepare the room wise list of electrical materials for the installation. Draw the schematic diagram showing the ratings of MCBs and sub circuits. Design is based on the NEC guide lines. Assume all required data. (10)

Module 4

17 a Explain the criteria for the design of bus-bar system of a Motor Control Centre (MCC). (4)

b) An industry consists of the following loads:

a. 7.5 kW, 3 phase cage induction motor – 1 No.
b. 11.2 kW, 3 phase cage induction motor – 2 Nos.
c. 22.5 kW, 3 phase cage induction motor – 1 No.

d. Power sockets – 15Nos.

e. Lighting loads - 40 Nos of 2 x 18 W LED lamps

f. Exhaust fans 100 W - 4 Nos.

Design the electrical system for the industry, if the industry is located in a village, and also determine:

i. Type of industry,

ii. Transformer capacity required and type of substation, and

iii. Draw the single line schematic diagram showing the details of cable size, starters and switch gears. Use a switch board with MCCB/SFU incomer and MCCB/SFU/MCB as outgoing and MCB type distribution board for lighting. (10)

18 a) Explain the design procedures of the MSB of an industry with predominantly motor loads. (4)

b) A factory has the following connected load:

i. Large motor of 150 kW - 1 no.
ii. Machine shop with 7.5 kW motors - 6 nos.
iii. Painting booth of 22.5 kW
iv. 10 kVA welding transformers - 4 nos.
v. Water pumping station load 15 kW
vi. Lighting load 5 kW

Select the transformer rating and design an indoor substation including the schematic diagram showing the details of switchgear and cable sizes. Assume a diversity factor of 1.2. (10)

Module 5

19 a) Draw the schematic diagram of a 400 A rising main arrangement for a five-storied building also give the rating of floor wise feeders and switchgears. (6)

b) Briefly explain the sizing of solar PV system for a domestic installation with a daily usage of 5 units. (8)

20 a) Draw the electric schematic diagram of a 320 kVA standby DG set with an AMF panel. Explain the essential potential and metering arrangements required in the generator control panel. (6)

b) Briefly explain the sizing of the battery bank of an off grid solar PV system to cater 3 kWh per day for a domestic installation. (8)

Syllabus

Module 1

IS Product Standards and Codes of practice, The Electricity Act 2003 and NEC 2011 (6 hours):

General awareness of IS Codes - IS 732 - IS 3043 –IS 2026- IS 3646-part 1&2 - IS 5216 part 1&2 - Electricity supply code-2014 (Relevance of each code in electrical installation applications only).

The Electricity Act 2003- General introduction- Distribution of Electricity (Part VI)- Central Electricity Authority (Part IX)- Regulatory Commissions (Part IX).

National Electric Code (NEC 2011) - Scope – Wiring installation (Section 9)- Short circuit calculations (Section 10).

Graphical symbols and signs as per NEC for electrical installations.

Classification of voltages-standards and specifications, tolerances for voltage and frequency.

Module 2

Lighting Schemes and calculations (6 hours):

Lighting design calculations - Definitions of luminous flux, Lumen, Luminous intensity/illuminance (Lux), Illumination calculations, factors affecting Coefficients of Utilisation (CoU) - and Light Loss Factor (LLF).

Benefits of LED lamps over the yesteryear luminaires – Efficacy of present-day LED lamps- Design of illumination systems – Average lumen method - Space to mounting height ratio- Design of lighting systems for a medium area seminar hall using LED luminaires

Exterior lighting design- point to point method - road lighting and public area lighting- Space to mounting height ratio - selection of luminaires- Metal Halide- High & Low pressure Sodium– LED lamps.

Module 3

Domestic Installation (10 hours)

General aspects as per NEC and IS 732 related to the design of domestic dwellings availing single phase supply (LV) and three phase supply (MV) for a connected load less than 15kW.

Load Survey- common power ratings of domestic gadgets- connected load-diversity factor-selection of number of sub circuits (lighting and power)-selection of MCB distribution boards to provide over load, short circuit and earth leakage protection.

Principle of operation of MCB, MCB Isolator, ELCB/RCCB and RCBO. Selection of CBs for protection and grading between major and minor sections.

Selection of wiring cables, conduits as per NEC and IS 732.

Design of electrical schematic and physical layout drawings for low and medium class domestic installation. Preparation of schedule of works and bill of quantities (cost estimation excluded).

Pre-commissioning tests- Insulation resistance measurement, continuity test, polarity test, and earth resistance measurement as applicable to domestic installations.

Module 4

Industrial Power and Lighting Installations (9 hours):

Industrial installations –classifications- Design of electrical distribution systems with main switch board, sub switch boards and distribution boards with ACBs, MCCBs and MCBs as the case may be, for feeding power (mainly motors) and lighting loads of small and medium industries.

Selection of armoured power cables (AYFY, A2XFY, YWY) – calculation of ampacity, voltage drop, short circuit withstand capacity etc.

Design of MSB & SSB including Motor Control Centre (MCC) for motor controls - selection of bus bars and switchgears.

Selection of 11kV indoor and outdoor transformer substations upto 630kVA - selection of switchgears and protective devices –Preparation of schedule of works and bill of quantities (cost estimation excluded).

Short circuit calculations and earthing design for the HV and LV sides of an 11 kV substation of capacity up to 630 kVA.

Pre-commissioning tests of 11kV indoor/outdoor substation of an HT consumer.

Module 5

High Rise building, Solar PV system, Standby generators and Energy conservation (8 hours):

Electrical installations of high-rise buildings: Distribution systems – rising main, cable system - Installation of lifts, standby generators, fire pumps - electric schematic drawing.

Selection of standby Diesel Generator set (DG set) –power rating - Continuous, Prime and Standby power ratings- installation and essential protections-Introduction to Automatic Mains failure (AMF) systems.

Energy Conservation Techniques in electrical power distribution - Automatic Power Factor Correction (APFC) panel – Principle of operation and advantages.

Introduction to Solar PV Systems, off-grid and on-grid systems, Solar panel efficiencies-design of a PV system for domestic application-Selection of battery for off-grid domestic systems.

Data Book (Use for Examination Hall)

1. Data Book Published by the University

Text/Reference Books

1. National Electrical Code 2011, Bureau of Indian Standards.
2. National Lighting Code 2010, Bureau of Indian Standards.
3. National Building Code of INDIA 2016 - Bureau of Indian Standards.
4. M. K. Giridharan, Electrical Systems Design, I K International Publishers, New Delhi, 2nd edition, 2016.
5. U.A.Bakshi, V.U.Bakshi Electrical Technology, Technical publications, Pune.
6. Narang K.L., A Text Book of Electrical Engineering Drawing, Tech India Publications.
7. J. B. Gupta, A Course in Electrical Installation Estimating and Costing, S.K. Kataria & Sons; Reprint 2013 edition (2013).
8. K. B. Raina, S. K. Bhattacharya, Electrical Design Estimating Costing, NEW AGE; Reprint edition (2010).

Website

1. www.price.kerala.gov.in (Reference for module 3 and 4)

Course Contents and Lecture Schedule:

Module	Topic coverage	No. of Lectures
1	**IS Codes, Ats, Rules and NEC (6 hours):**	
1.1	General awareness of IS Codes - IS 732 - IS 3043 –IS 2026- IS 3646-part 1&2 - IS 5216 part 1&2 - Electricity supply code-2014 (Relevance of each code in electrical installation applications only). The Electricity Act 2003- General introduction- Distribution of Electricity (Part VI)- Central Electricity Authority (Part IX)- Regulatory Commissions (Part IX).	2
1.2	National Electric Code (NEC 2011) - Scope – Wiring installation (Section 9)- Short circuit calculations (Section 10).	2
1.3	Graphical symbols and signs as per NEC for electrical installations. Classification of voltages-standards and specifications, tolerances for voltage and frequency.	2
2	**Lighting Schemes and calculations (6 hours):**	
2.1	Lighting design calculations - Definitions of luminous flux, Lumen, Luminous intensity/illuminance (Lux), Illumination calculations, factors affecting Coefficients of Utilisation (CoU) - and Light Loss Factor (LLF).	2
2.2	Benefits of LED lamps over the yesteryear luminaires – Efficacy of present-	2

	day LED lamps-Design of illumination systems – Average lumen method - Space to mounting height ratio- Design of lighting systems for a medium area seminar hall using LED luminaires	
2.3	Exterior lighting design- point to point method - road lighting and public area lighting- Space to mounting height ratio - selection of luminaires- Metal Halide- High & Low pressure Sodium– LED lamps.	2
3	**Domestic Installation (10 hours):**	
3.1	General aspects as per NEC and IS 732 related to the design of domestic dwellings availing single phase supply (LV) and three phase supply (MV) for a connected load less than 15kW.	2
3.2	Load Survey- common power ratings of domestic gadgets- connected load- diversity factor-selection of number of sub circuits (lighting and power)- selection of MCB distribution boards to provide over load, short circuit and earth leakage protection.	2
3.3	Principle of operation of MCB, MCB Isolator, ELCB/RCCB and RCBO. Selection of CBs for protection and grading between major and minor sections. Selection of wiring cables, conduits as per NEC and IS 732.	2
3.4	Design of electrical schematic and physical layout drawings for low and medium class domestic installation. Preparation of schedule of works and bill of quantities (cost estimation excluded). Pre-commissioning tests- Insulation resistance measurement, continuity test, polarity test, and earth resistance measurement as applicable to domestic installations.	4
4	**Industrial installations (9 hours):**	
4.1	Industrial installations –classifications- Design of electrical distribution systems with main switch board, sub switch boards and distribution boards with ACBs, MCCBs and MCBs as the case may be, for feeding power (mainly motors) and lighting loads of small and medium industries. Selection of armoured power cables (AYFY, A2XFY, YWY) – calculation of ampacity, voltage drop, short circuit withstand capacity etc.	3
4.2	Design of MSB & SSB including Motor Control Centre (MCC) for motor controls - selection of bus bars and switchgears.	2

4.3	Selection of 11kV indoor and outdoor transformer substations upto 630kVA - selection of switchgears and protective devices –Preparation of schedule of works and bill of quantities (cost estimation excluded). Short circuit calculations and earthing design for the HV and LV sides of an 11 kV substation of capacity up to 630 kVA.	3
4.4	Pre-commissioning tests of 11kV indoor/outdoor substation of an HT consumer.	1
5	**High Rise building, Solar PV system, Standby generators and Energy conservation (8 hours):**	
5.1	Electrical installations of high-rise buildings: Distribution systems – rising main, cable system - Installation of lifts, standby generators, fire pumps - electric schematic drawing.	2
5.2	Selection of standby Diesel Generator set (DG set) –power rating - Continuous, Prime and Standby power ratings- installation and essential protections-Introduction to Automatic Mains failure (AMF) systems.	3
5.3	Energy Conservation Techniques in electrical power distribution - Automatic Power Factor Correction (APFC) panel – Principle of operation and advantages.	1
5.4	Introduction to Solar PV Systems, off-grid and on-grid systems, Solar panel efficiencies-design of a PV system for domestic application-Selection of battery for off-grid domestic systems.	2