

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2022 (COGC-2022)

Semester-IV

Course Title: Electrical Wiring Estimating, Costing and Contracting

(Course Code: 4340903)

| Diploma programmer in which this course is offered | Semester in which offered |
|--|---------------------------|
| Electrical Engineering | 4 th Semester |

1. RATIONALE

Electrical wiring plays a major role in distributing the electrical energy from electric utilities to consumer. Electrical diploma holders may work as Technicians and Supervisors for planning, installing, and testing various electrical wiring Installations such as residential, commercial and Industrial electrification schemes. They should be able to prepare costing and estimates for these schemes with a thorough understanding of the methods/procedure of estimating, tendering/ contracting is desired. Knowledge of IE rules for different types of electrical Installation, their planning considerations equips the students with the capability to plan and prepare different Installation projects. Essential efforts are made in this course to develop above skills in the students.

2. COMPETENCY

The purpose of this course is to help the student to attain the following competency through various teaching learning experiences

- Carry out Electrical wiring estimating, costing and contract for various electrical installations.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

- a) Select relevant wiring methods, tools, and accessories for electrical installations.
- b) Undertake tendering and purchase procedure.
- c) Estimate cost of various domestic and industrial installation as per IE Act-2003
- d) Estimate the materials and cost of electrification for different buildings
- e) Estimate cost of distribution line project as per IE Act-2003

4. TEACHING AND EXAMINATION SCHEME

| Teaching Scheme (In Hours) | | | Total Credits (L+T+P/2) | Examination Scheme | | | | |
|-------------------------------|---|---|----------------------------|--------------------|-----|-----------------|-----|----------------|
| | | | | Theory Marks | | Practical Marks | | Total Marks |
| L | T | P | C | CA | ESE | CA | ESE | |
| 3 | 0 | 2 | 4 | 30* | 70 | 25 | 25 | 150 |

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be

taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: *L*-Lecture; *T* – Tutorial/Teacher Guided Theory Practice; *P* - Practical; *C* – Credit, *CA* - Continuous Assessment; *ESE* - End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the **PrOs** marked '*' are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'.

| Sr. No. | Practical Outcomes (PrOs) | Unit No. | Approx. Hrs. Required |
|---------|---|----------|-----------------------|
| 1 | Undertake following wirings. a) Staircase Wiring b) Go down wiring | I | 2 |
| 2 | Select appropriate wiring and list materials and accessories for given project | I | 2 |
| 3 | Perform domestic Electrical Installation test. | I | 4 |
| 4 | Prepare Inquiry form, quotation, comparative statement, and order for any electrical work/materials required /small projects. | II | 4 |
| 5 | Prepare a tender notice for given project. | II | 4* |
| 6 | Prepare cost estimate of a domestic installation cost (Residential building/ Laboratory building/Drawing Hall etc. | III | 4* |
| 7 | Prepare cost estimate of an Industry Installation. (Workshop/ Agriculture, Flour mill, etc.) | III | 4 |
| 8 | Interpret and prepare electrical test report of a large building or complex. | IV | 4* |
| 9 | Calculate Load for lift, and air conditioning in high rise building. (A group of 5 students, having one different complex per group.) | IV | 4 |
| 10 | Prepare cost estimate of an Overhead service connection. (Single phase/Three phase) | V | 4* |
| 11 | Prepare cost estimate of an Underground service connection (Single phase/three phase) | V | 4 |
| 12 | Estimate of material and specification required for 440V, 3-phase, 4 wire or 3 wire Overhead Distribution line. | V | 4* |
| | Total Hours (Perform any practical worth 28 hours from above depending upon the availability of resources so that most units are covered | | 44 Hrs |

Note

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the Cos.

ii. The following are some sample 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

| Sr. No. | Sample Performance Indicators for the PrOs | Weightage in % |
|--------------|--|----------------|
| 1 | Prepare experimental setup/layout/line diagram | 20 |
| 2 | Use of the relevant wiring tools/materials | 20 |
| 3 | Follow safe practices. | 20 |
| 4 | Timely submission of work. | 20 |
| 5 | Answer to sample questions. | 20 |
| Total | | 100 |

5. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to use in uniformity of practical in all institutions across the state.

| Sr.No. | Equipment Name with Broad Specifications | PrO. No. |
|--------|--|----------|
| 1 | Electrician tool kit-01 Nos. | 1 to 3 |
| 2 | Wiring Materials | 1 to 3 |
| 3 | Megger 500 V-01 Nos. | 03 |

6. AFFECTIVE DOMAIN OUTCOMES

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

- a) Work as a leader/a team member (while doing a micro-project)
- b) Follow safety practices.
- c) Work as a group member (while performing experiments and taking readings)
- d) Follow ethical practices.
- e) **Practice environmentally friendly methods and processes. (Environment related)**

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- i. 'Valuing Level' in 1st year
- ii. 'Organization Level' in 2nd year.
- iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

| Unit | Unit Outcomes (UOs) (4 to 6 UOs at different levels) | Topics and Sub-topics |
|---|---|--|
| Unit – I Electrical Wiring and IE Rules | 1a. Differentiate between different types of wiring system 1b. List the applications of different types of wiring tools 1d Explain the IE rules of wiring. | 1.1 Types of wires, wiring system. 1.2 Specifications of Different types of wiring materials, Accessories 1.3 Wiring tools. 1.4 Wiring circuits. 1.5 I.E. rules for wiring, IE Act-2003. |
| Unit-II Elements of Estimating and concepts of contracting | 2a Classify types of estimation and estimation tools 2b Describe Purchase procedure 2c Explain the types of contracts and contractors. 2d Explain the concept of contracts and Tenders 2e Explain the procedure for submission and opening of tenders. 2f Explain the principles of Execution of works 2g Explain the procedure for Billing of executed work 2h Explain the specified actions for e-tendering. | 2.1 Estimation and estimation tools. 2.2 Electrical Schedule of rates, catalogues, Survey and source selection, Recording estimates 2.3 Quantity and cost of material required. 2.4 Purchase system, Purchase inquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills 2.5 Types of contract system. 2.6 Tendering procedure and preparation of simple tender, method of opening tender and e-tender 2.7 Earnest Money Deposit, Security Deposit |
| Unit– III Estimating and Costing of Domestic and Industrial Wiring | 3a. Prepare Layout and wiring diagram for domestic wiring. 3b. Calculate the Load, quantity and cost of material required for domestic wiring. 3c. Prepare Layout and wiring diagram for industrial wiring. 3d. Calculate the Load, quantity and cost of material required for | 3.1 General rules for wiring 3.2 Layout of wiring. 3.3 Number of points (light, fan, socket outlets, etc.) 3.4 Total load and number of sub-circuits. 3.5 Size of conductor. 3.6 Ratings of main switch and distribution board. 3.7 Case studies-Domestic wiring. 3.8 Important consideration regarding Motor Installation Wiring. 3.9 Input current to motors |

| Unit | Unit Outcomes (UOs) (4 to 6 UOs at different levels) | Topics and Sub-topics |
|--|---|---|
| | industrial wiring. | 3.10 Rating of cables, safety accessories 3.11 Size of conduit, distribution board, main switch, and starter. 3.12 Case studies-Industrial Wiring |
| Unit– IV Electrification of multistoried building | 4a. Calculate total load on electrical distribution work. 4b. Estimate floor wise electrical material requirements 4c. Calculate the size of bus bar, cables, panels. 4d. Maintain smoke detection system in multistoried buildings. 4e. Maintain Diesel Generator set as a standby unit. | 4.1 Calculation total electrical load on distribution work 4.2 Floor wise estimation of material requirements i) Specification of wiring material and accessories. ii) Estimation of total cost of electrification using schedule of rates (SOR) 4.3 Case studies 4.4 Requirements of approval from electrical inspection for high rise multistoried building 4.5 Load calculation for lifts, escalators, air conditioners 4.6 Distribution panels and bus bar system 4.7 Fire alarm system 4.8 Smoke detection system 4.9 Use of D.G. set as a standby power supply in case of emergency. |
| Unit–V Estimation of Overhead and Underground Distribution System | 5a. Draw layout of overhead distribution line. 5b. Prepare plan of overhead distribution project work. 5c. Determine main components and specification of overhead distribution system. 5d. Estimate quantity of material and cost required for an overhead distribution project work. 5e. Explain types of service connection. 5f. Explain I.E. rules related to overhead lines and service connection. | 5.1 Overhead distribution system. 5.2 Line supports, Factors governing height of pole 5.3 cross arms, pole brackets and clamps, guys and stays, conductor's configuration spacing and clearances, span lengths, overhead line insulators, insulator materials lightning arrestors, erection of supports, setting of stays, 5.4 Earthing of lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between supports conductors 5.5 Materials and accessories required for the overhead distribution system. 5.6 Estimate for 440 V, 3-phase, 4 wires or 3 wires overhead distribution system. 5.7 Describe Method of installation |

| Unit | Unit Outcomes (UOs) (4 to 6 UOs at different levels) | Topics and Sub-topics |
|------|---|--|
| | | of service connection (1-phase and 3-phase), observing I.E. rules 5.8 Types of service connections 5.9 I.E. rules pertaining to overhead lines and service connection. 5.10 Case studies. |
| | 5g. Draw layout of underground distribution system. 5h. Prepare plan of underground distribution project work. 5i. Determine main components and specification of underground distribution system. 5j. Estimate quantity of material and cost required for a overhead distribution project work. | 5.11 Underground distribution system. 5.12 Materials and accessories required for underground distribution system. 5.13 Estimate for 440 V, 3-phase, 4 wires or 3 wires underground distribution system. 5.14 I.E. rules pertaining to underground system and service connection. 5.15 Case studies. |

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

| Unit No. | Unit Title | Teaching Hours | Distribution of Theory Marks | | | |
|--------------|--|----------------|------------------------------|-----------|-----------|-------------|
| | | | R Level | U Level | A Level | Total Marks |
| I | Electrical Wiring and IE Rules | 6 | 04 | 04 | 02 | 10 |
| II | Elements of Estimating and concepts of contracting | 6 | 04 | 04 | 02 | 10 |
| III | Estimating and Costing of Domestic and Industrial Wiring | 8 | 04 | 05 | 06 | 15 |
| IV | Electrification of multistoried building | 10 | 02 | 05 | 05 | 12 |
| V | Estimation of Overhead and Underground Distribution System | 12 | 05 | 09 | 09 | 23 |
| Total | | 42 | 19 | 27 | 24 | 70 |

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the

various outcomes in this course. Students should perform following activities in group (or individual) and prepare reports of about 5 pages for each activity. They should also collect/record physical evidence for their (student's) portfolio which may be useful for their placement interviews:

- a) Prepare abstract of Indian standards related to industrial and non-industrial installations.
- b) Summarize given section of National Electrical Code (NEC), 2011 required for electrical installation.
- c) Prepare report on market survey of various electrical accessories, wires, and cables (specification, manufacture, quality, cost, etc.)
- d) Collect any one electrical drawing of existing electrical installation and prepare for the same.
- e) Collect information of tender published in newspaper or e-tender related to industrial or non-industrial electrical installation and fill necessary documents.
- f) Prepare power point presentation for acquiring electrical installation work.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (**MOOCs**) may be used to teach various topics/subtopics.
- b) Guide student(s) in undertaking micro-projects.
- c) **'L' in section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- d) About **15 to 20% of the topics/subtopics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentation.
- e) With respect to item No. 10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- f) Field visit/Industrial visit.
- g) Show animation/video related to course content
- h) Guide students on how to address issues on environment and sustainability
- i) Introduce E-waste recycling technology among the students.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based, or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **12-14 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This must match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) **Electrical Diagrams:** Prepare report on existing electrical drawings.
- b) **Domestic and commercial Installations:** Collect civil drawing plan and prepare estimation for the same.
- c) **Industrial Installations:** Collect industrial installation plan and prepare estimation for the same.
- d) **Distribution lines:** Collect existing installation plan of distribution lines and prepare estimation for the same.
- e) **Contracting:** Collect any tender document related to electrical installation and fill all related documents.

13. SUGGESTED LEARNING RESOURCES

| Sr. No. | Title of Book | Author | Publication with place, year and ISBN |
|---------|--|------------------------------------|---|
| 1 | Electrical Design, Estimating and Costing | Raina, K.B. and Bhattacharya, S.K. | New Age International publisher, First, reprint 2010, ISBN: 978-81-224-0363-3 |
| 2 | Electrical Estimating and Costing | Uppal, S.L. | Khanna Publisher New Delhi, ISBN 9788174092403 |
| 3 | Electrical Installation Estimating and costing | Gupta, J.B. | S.K. Kataria and sons; New Delhi Reprint Edition. 2013, ISBN:13:9789350142790 |
| 4 | I.E. rules for wiring, Electricity supply act-1948 | Bureau of Indian Standards | Electricity supply act-1948 |
| 5 | Relevant IS Code for-service line connection, laying of cable, wiring installation | NBC | National Building Code-Vol. IV |
| 6 | IS: 732-1989, code of practice for Electrical Wiring Installation | Bureau of Indian Standards | IS: 732-1989, |

14. SOFTWARE/LEARNING WEBSITES

WEBSITES

- <https://ask-the-electrician.com/wiringdiagrams.html>
- <https://www.electricaltechnology.org/2013/09/electrical-wiring.html>
- <https://www.electrical4u.com/electrical-engineering-articles/utilities/>
- <https://home.howstuffworks.com/home-improvement/repair/how-to-do-home-electrical-repairs.htm>
- <http://www.neca-neis.org/the-standards>

15. PO-COMPETENCY-CO MAPPING:

| Semester IV | Electrical Wiring Estimating, Costing and Contracting | | | | | | |
|--|---|--------------------------|--|--|---|----------------------------|----------------------------|
| | POs | | | | | | |
| Competency & Course Outcomes | PO 1 Basic & Discipline specific knowledge | PO 2 Problem Analysis | PO 3 Design/development of solution | PO4 Engineerig Tools, Experimentation&Testing | PO 5 Engineering practices for society, sustainability & environment | PO 6 Project Management | PO 7 Life-long learning |
| Competency | Carry out Electrical wiring estimating, costing and contract for various electrical installations. | | | | | | |
| Course Outcomes CO1 Select relevant wiring methods, tools, and accessories for electrical installations. | 3 | 2 | - | 2 | 2 | | 2 |
| CO2 Undertake tendering and purchase procedure. | 3 | - | - | - | 3 | 2 | 2 |
| CO3 Estimate cost of various domestic and industrial installation as per IE Act-2003 | 2 | - | 2 | - | 2 | 2 | 2 |
| CO4 Estimate the materials and cost of electrification for different buildings | 2 | 2 | 2 | 2 | 2 | - | 2 |
| CO5 Estimate cost of distribution line project as per IE Act-2003 | 2 | - | 2 | - | 2 | 2 | 2 |

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE**GTU Resource Persons**

| S. No | Name and Designation | Institute | Contact No. | Email |
|-------|---|---------------|-------------|--|
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