

Liverpool John Moores University

Title: ELECTRICAL ENGINEERING AND SERVICES SYSTEMS
Status: Definitive
Code: **5114BEUG** (118149)
Version Start Date: 01-08-2014

Owning School/Faculty: Built Environment
Teaching School/Faculty: Built Environment

Team	Leader
Laurence Brady	Y

Academic Level: FHEQ5 **Credit Value:** 24.00 **Total Delivered Hours:** 75.00

Total Learning Hours: 240 **Private Study:** 165

Delivery Options

Course typically offered: Standard Year Long

Component	Contact Hours
Lecture	48.000
Tutorial	24.000

Grading Basis: 40 %

Assessment Details

Category	Short Description	Description	Weighting (%)	Exam Duration
Exam	AS1		70.0	3.00
Report	AS2		30.0	

Aims

To further develop an appreciation of the principle concepts of electrical engineering and relate these to the power requirements of a range of buildings and the methods by which the power can be supplied and distributed.

To further develop an appreciation of the principle concepts of light and relate these to the practice of incorporating lighting into buildings.

To provide students with the knowledge and skills necessary to interpret the

electrical and lighting needs and requirements of buildings to develop and evaluate practical schemes, paying due regard to sustainable development and energy efficiency.

To critically analyse and evaluate the concepts underpinning the electrical installations regulations (BS7671).

Learning Outcomes

After completing the module the student should be able to:

- 1 Analyse AC circuits containing resistance, inductance and capacitance connected in series and parallel.
- 2 Use complex notation and graphical methods to determine real power, apparent power, reactive power and power factor in AC circuits.
- 3 Analyse and evaluate the performance of transformers, high voltage switchgear and protective devices in power supply systems.
- 4 Investigate lighting equipment and the visual effects of lighting
- 5 Analyse a variety of buildings ranging from simple domestic buildings to complex commercial and industrial buildings to identify, evaluate and justify the need for electrical building services systems and lighting schemes, paying due regard to sustainable development, legislation and design guidance;
- 6 Produce detailed designs for electrical services systems and lighting installations for a range of buildings and evaluate these in terms of utility, building user requirements, sustainability and energy efficiency;
- 7 Analyse and evaluate methods of determining fault levels and protecting against overcurrent, thermal effects and electric shock in power supply networks and electrical distribution systems.
- 8 Investigate and evaluate the requirements for standby and uninterruptible power supplies systems and emergency lighting systems for a range of public, commercial and industrial buildings.

Learning Outcomes of Assessments

The assessment item list is assessed via the learning outcomes listed:

EXAMINATION	1	2	3	8
REPORT	4	5	6	7

Outline Syllabus

Generation of electrical energy – generators and generating stations,

Transmission of electrical energy – power lines, overhead lines and cables.

Distribution of electric energy – substation equipment, medium-voltage and low-voltage distribution.

Circuit analysis – complex numbers, complex representation of sinusoidal quantities, Kirchhoff's laws

Single phase AC circuits – series and parallel circuits, resistance, inductance and

capacitance connected in series and parallel, resonance, power factor, real, apparent and reactive power.

Three phase circuits – balanced and unbalanced, star and delta load configurations. Transformers: electromagnetic induction, transformer principles, phasor diagrams, equivalent circuits, referred values, transformer tests, efficiency and regulation, parallel operation and group references, protection transformers.

Network theorems in dc and ac circuits inductance, capacitance, alternating voltage and current, single phase ac circuits.

Multiphase systems, transformers, power systems, faults.

DC and AC motors: electromagnetic forces, motor principle, dc series/shunt motors, speed/torque characteristics, production of rotating magnetic field, induction/synchronous motor principles and characteristics, starting methods, inverters, soft-start, DOL, star delta etc, speed control, motor selection and ratings. Operating principles of inverters, use of inverters to control speed of motors.

Power assessment: power demand and load factors, assessment of demand for the range of buildings. Specification and requirements: analysis of client and building needs.

Supply Options: tariff arrangements and alternative supply options, comparison of alternative tariffs, choice of supply voltage, requirements of suppliers network.

Fault currents: types of faults, percentage and p.u. values, fault levels, short circuit currents, network configurations, network analysis for fault levels.

Design criteria: design, designing for health and safety. Alternative approaches. Assessment of electrical load design standards and publications.

Accommodation of distribution services: distribution patterns, horizontal, vertical, provision for future development and access. Coordination of services. False floor systems, rising mains, sub-main, bus-bar, trunking, conduit, ducting etc.

Environmental issues: vibration, noise, thermal, loads.

Fundamental requirements for safety: periodic inspection; acceptable test percentages, reasons for poor results, format of report, EEBAD for TT and IT supply systems.

Applying designers discretion: volts drop, diversity, extending disconnection times, thermal effects, grouping of cables of different csa and load characteristics, sizing of cables for motor circuits: direct on line, star delta, and inverter control.

Circuit protection: over current and short circuit protection, protection for variable loads.

Determining and protecting against fault currents. Discrimination between protective devices, fuses, MCB, MCCB. Operating time ranges, tripping characteristics.

Common types of heavy current fuses. Select fuses, MCB.s, and MCCB.s for various applications from manufacturers data.

Data Distribution: Category of circuits, types of distribution, WAN, LAN, Category five and six installations, cable types, clean and dirty earth's, earth loops, interference, emission of heat, vibration, earth leakage currents, data/telecommunication installations, electromagnetic compatibility; conducted, electrostatic, radiated.

Lightning protection: determining susceptibility to lightning strike, air termination network, down conductors, earth termination networks, bonding, side flashing, protection of electrical and data equipment within buildings, cable routes and equipment location.

Feasible solutions: Establishment of alternative options, techniques for critical analysis of alternative solutions to identify most feasible.

Standby supplies: essential, critical, non-essential loads, Generator installations, single and multi-generator, automatic start-up arrangements, synchronisation. Protection against over-current, reverse-power, voltage, frequency etc. Generator fuel and efficiency.

UPS systems; single phase, three phase-three phase, three phase-single phase. Static switch/by-pass.

Fundamentals of lighting: terminology and units of light, inverse square law, cosine law, colour temperature.

Visual effects of lighting: lighting levels, glare, illumination for task performance, appearance, colour rendering, revealing form, display lighting, light modulation.

Specification and requirements: analysis of client and building requirements, balance between client, commercial, aesthetic and energy efficiency considerations. Requirements of specialised lighting situations Interpretation and application of lighting design standards, publications for complex public sector commercial and industrial buildings. Co-ordination of lighting with other mechanical and electrical services.

Daylighting: Features, significance, advantages & disadvantages of daylight in buildings. Components of the daylight factor. Sunlight admission. Impact of different forms, shapes, proportion and location of window and rooflights. Effect of glass type, window bars etc.. Daylight in buildings with atria, advantages and disadvantages. Effect of daylighting on VDU equipment. Techniques for increasing daylight levels and penetration into buildings. No-sky lines, light obstruction and visible sky angles. Day light requirements. Average daylight factors. Manual and Computer calculation/modeling of distribution of daylight in buildings.

Light sources: natural daylight, lamp types and classifications, identification codes, lamp characteristics, luminous efficacy, lamp life and luminous flux maintenance, lamp control gear.

Luminaires: standards and markings, luminaire characteristics, luminaires for hostile and hazardous environments, polar curves and other photometric data, use of illuminance ratio charts, switching and dimming, maintenance. Methods of control.

Design of general lighting systems: for complex and specialised buildings. Layout, specification and control of interior lighting. Exterior lighting, car parks and walkway lighting, integration of lighting with other services installations, integration of artificial lighting with natural day-lighting.

Lift Operation & requirements: Passenger, goods and service lifts, fire fighting, evacuation and lifts for the disabled.

Lift control: attendant, single automatic push button control, collective, duplex, dispatch. Speed control safety devices, services in lift wells.

Roping and winding systems: above well, below well, compensating. Geared and gearless winding.

Hydraulic lifts: control, oil cooling.

Design of lift & Escalators: location of lifts, grouping. Assessment of demand: waiting time, handling capacity, arrival rate, estimation of population, daily occupancy, building type and height.

Passenger demand: handling capacity, traffic profiles, up-peak, round trip time, calculation of handling capacity.

Escalators and walkways: safety devices, discharge capacity, fire control, guards at intersections, angle of inclination.

Learning Activities

Lectures, tutorials and case studies.

References

Course Material	Book
Author	BSI
Publishing Year	2008
Title	Requirements for electrical installations : IEE wiring regulations / BSI and the Institution of Electrical Engineers
Subtitle	BS 7671 ; 2008
Edition	17th
Publisher	The Institution of Engineering and Technology and BSI
ISBN	9780863418440

Course Material	Book
Author	Cook P
Publishing Year	2010
Title	Commentary on IEE Wiring Regulations: BS 7671:2008 requirements for electrical installations
Subtitle	
Edition	17th
Publisher	IET
ISBN	9780863419669

Course Material	Book
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Author	Hughes E., Hiley J. et al
Publishing Year	2012
Title	Hughes Electrical and Electronic Technology
Subtitle	
Edition	11th
Publisher	Pearson
ISBN	0132060116

Course Material	Book
Author	Robertson C.R
Publishing Year	2008
Title	Fundamental Electrical and Electronic Principles
Subtitle	
Edition	3rd
Publisher	Butterworth Heinemann
ISBN	9780750687379

Course Material	Book
Author	Bayliss C
Publishing Year	2012
Title	Transmission and Distribution Electrical Engineering
Subtitle	
Edition	4th
Publisher	Newnes
ISBN	9780080969121

Course Material	Book
Author	CIBSE
Publishing Year	2005
Title	Guide K: Electricity in Buildings
Subtitle	
Edition	
Publisher	CIBSE
ISBN	9781903287262

Course Material	Book
Author	Cheshire, D.
Publishing Year	2012
Title	Guide F: Energy Efficiency in Buildings
Subtitle	
Edition	
Publisher	CIBSE
ISBN	9781906846220

Course Material	Book
Author	CIBSE
Publishing Year	2010

Title	Guide E: Fire Engineering
Subtitle	
Edition	3rd
Publisher	CIBSE
ISBN	9781906846138

Course Material	Book
Author	CIBSE
Publishing Year	2002
Title	Code for Lighting
Subtitle	
Edition	
Publisher	Butterworth-Heinemann
ISBN	9781903287514

Course Material	Book
Author	Society of Light and Lighting
Publishing Year	2006
Title	LG12: Emergency Lighting and Design
Subtitle	
Edition	
Publisher	Society of Light and Lighting
ISBN	1903287510

Course Material	Book
Author	Tregenza P
Publishing Year	1998
Title	The Design of Lighting
Subtitle	
Edition	
Publisher	E. & F.N. Spon
ISBN	9780419204404

Course Material	Book
Author	BSI
Publishing Year	2011
Title	Requirements for electrical installations: IET wiring regulations, seventeenth edition: British Standard BS 7671:2008 incorporating amendment no. 1, 2011 / British Standards Institution
Subtitle	
Edition	17th
Publisher	Institution of Engineering and Technology
ISBN	9781849192699

Notes

This module develops the student's understanding of the principle concepts of electrical engineering and lighting, and the technology associated with the provision of electrical power supply to a range of buildings. It offers a detailed appreciation of power supplies to buildings, electrical distribution within buildings and lighting schemes for buildings suitable for all students studying Building Services Engineering and associated disciplines.