

A CORPUS-BASED ANALYSIS OF LEXICAL PATTERNS IN ELECTRICAL ENGINEERING TEXTBOOKS

Oleh : Danu Angga Vebriyanto¹, Filda Hulwani Dewi², Diah Wulansari Hudaya³,
Rangga Permana⁴

^{1,2}Teknik Elektro, Politeknik Negeri Semarang

³Teknik Sipil, Politeknik Negeri Semarang

⁴Akuntansi, Politeknik Negeri Semarang

E-mail : danu.anggavebriyanto@polines.ac.id

Abstrak

Peneliti melakukan analisis komprehensif berbasis korpus terhadap 15 buku teks teknik listrik untuk mengidentifikasi fitur leksikogramatikal khasnya. Menggunakan perangkat lunak AntConc, penelitian ini berfokus pada dua aspek utama: kata benda, kata kerja, dan kata sifat yang paling sering muncul, serta kolokasi leksikal yang paling umum. Temuan menunjukkan dominasi konsisten dari kata benda teknis inti seperti voltage, figure, power, current, dan circuit, yang berfungsi sebagai elemen konseptual sentral dalam bidang tersebut. Kata kerja frekuensi tinggi seperti shown, used, dan given menyoroti sifat deskriptif dan prosedural wacana, sering muncul dalam nada objektif dan impersonal. Selain itu, analisis mengungkap kolokasi spesifik disiplin yang signifikan (misalnya, voltage drop, current flow) dan bundel leksikal ("as shown in Figure," "in this circuit"), menunjukkan sifat formula dan terangkai dari bahasa teknik. Pola-pola berulang ini menggarisbawahi pentingnya komunikasi dan nilai pedagogisnya. Hasil penelitian ini menawarkan bukti empiris untuk merancang kurikulum English for Specific Purposes (ESP) yang lebih efektif, mengembangkan sumber daya kosakata khusus, dan meningkatkan materi buku teks untuk mendukung mahasiswa teknik dalam memperoleh kefasihan akademik dan profesional..

Kata kunci : Linguistik korpus, Teknik elektro, ESP, Leksikogramar, Kolokasi.

Abstract

This study conducted a comprehensive corpus-based analysis of 15 prominent electrical engineering textbooks to identify their characteristic lexicogrammatical features. Utilizing AntConc software, the research focused on two key aspects: the most frequently occurring nouns, verbs, and adjectives, and the most common lexical collocations. Findings revealed a consistent dominance of core technical nouns such as voltage, figure, power, current, and circuit, which serve as central conceptual elements in the field. High-frequency verbs like shown, used, and given highlighted the descriptive and procedural nature of the discourse, often appearing in an objective, impersonal tone. Furthermore, the analysis uncovered significant discipline-specific collocations (e.g., voltage drop, current flow) and lexical bundles ("as shown in Figure," "in this circuit"), indicating the formulaic and chunked nature of engineering language. These recurrent patterns underscore their communicative importance and pedagogical value. The study's results offer empirical evidence for designing more effective English for Specific Purposes (ESP) curricula, developing specialized vocabulary resources, and enhancing textbook materials to better support engineering students in acquiring academic and professional fluency.

Keywords : Corpus linguistics, Electrical engineering, ESP, Lexicogrammar, Collocations

1. Introduction

English for Specific Purposes (ESP) has a vital role in allowing students and professionals to effectively engage with specialized academic and professional discourse (Paltridge & Starfield, 2013). Within the realm of engineering, proficiency in English is paramount for understanding

complex technical concepts, interpreting research findings, and communicating effectively in a globalized professional landscape (Flowerdew & Peacock, 2016). Electrical engineering, a highly specialized and quantitative field, relies heavily on precise and consistent linguistic formulations to convey intricate theoretical principles,

analytical procedures, and practical applications. The distinctive nature of its discourse, characterized by a unique blend of technical terminology and conventional phraseology, necessitates targeted linguistic instruction for non-native English speakers pursuing engineering education (Hyland, 2011).

Despite the acknowledged importance of language in engineering education, there remains a need for empirically-driven insights into the specific lexicogrammatical features that characterize electrical engineering textbooks. Previous research in ESP has highlighted the significance of corpus linguistics as a robust methodology for identifying authentic language use in specialized domains (Biber, Conrad, & Reppen, 2007; McEnery & Wilson, 2019). By systematically analyzing large collections of real-world texts, corpus studies can reveal patterns of vocabulary, collocations, and grammatical structures that are central to a particular discipline, offering a data-driven foundation for curriculum development and pedagogical practices (Nation, 2016; Sinclair, 2004).

This study, therefore, aims to contribute to the existing body of ESP research by conducting a corpus-based investigation into the lexicogrammatical contents of prominent electrical engineering textbooks. Specifically, this research addresses two key questions: What are the most frequently occurring nouns, verbs, and adjectives in electrical engineering textbooks?

What are the most common lexical collocations in the corpus?

By exploring these questions, the findings are intended to provide concrete empirical evidence regarding the linguistic characteristics of electrical engineering texts, thereby informing the design of more effective ESP curricula, the development of specialized vocabulary resources, and the enhancement of textbook materials for engineering students. Ultimately, this research seeks to bridge the gap between theoretical understanding of language in ESP and practical applications in engineering education, supporting students in

achieving greater academic and professional fluency.

2. Method

The present study employed a corpus-based study. It is a language study on a large collection of actual language use which is stored in computerized databases or corpora (McEnery and Wilson, 2019). In this study, a specialized corpus was meticulously constructed employing 15 prominent electrical engineering textbooks published within the time frame of 2000 to 2022 which are elaborated in the table 1. Those textbooks were selected for their academic relevance and comprehensive coverage of core topics. The compilation exclusively encompassed the essential instructional content. The selected texts then digitization to facilitate compatibility with AntConc software (Anthony, 2022). The final corpus comprises a total of 3,066,570 tokens.

Table 1: List of textbooks used for the present study

No	Title	Year	Author
1	Introduction to electrical engineering	2010	Mulukutla S. Sarma
2	English for electrical engineering	2018	Naely Muchtar & Alimin
3	English for electrical engineering in higher education series	2014	Roger H. C. Smith
4	Electrical Engineering Step by Step Basics, Components Circuits explained for Beginners	2022	Johannes Wild
5	Advanced English for electrical engineering	2024	Susilawati
6	The Electrical Engineering Handbook	2000	Richard C. Dorf

7	GATE 2019 Electrical Engineering Previous Years Solved Question Papers	2018	Trishna Knowledge Systems
8	Fundamentals of electric power engineering	2015	Isaak D. Mayergoyz
9	Electrical power transmission system engineering analysis and design	2014	Turan Gönen
10	Electrical Engineering. Know It All	2008	Clive Maxfield, John Bird, Tim Williams etc
11	Electrical Engineering Principles and applications	2016	Allan R Hambley
12	Electrical Engineering Fundamentals	2020	S. Bobby Rauf
13	Electrical Engineering	2014	V. Venkatesh
14	Electrical Engineering	2020	Engineers Academy Publication
15	Basic Electrical Engineering, 3rd Edition	2010	D. P. Kothari & I. J. Nagrath

The analytical procedure was conducted utilizing AntConc version 4.3.1. The Word List tool was employed to derive frequency counts, subsequently identifying the top 100 most frequently occurring words following the exclusion of standard stopwords. These identified words were systematically categorized into content words and function words. To investigate collocations, the Collocates tool was implemented with a five-word span on either side of the node word, concentrating on discipline-specific content

words. The Concordance and Clusters/N-Grams tools were utilized to examine these collocations within their contextual framework.

3. Results

3.1 Most Frequently Used Words in Electrical Engineering

The word frequency analysis revealed that the most common content-specific terms in the corpus of 15 electrical engineering textbooks included voltage, figure, power, current, and circuit. The first one hundred of words are those shown in Table 2 below with their frequencies. The remaining words were then manually classified into parts of speech categories, with a primary focus on nouns, verbs, and adjectives relevant to technical discourse.

Table 2: Frequency of the first 100 words in electrical engineering textbooks

No	Word	Freq	No	Word	Freq
1	voltage	14091	51	digital	2449
2	figure	13410	52	point	2417
3	power	13236	53	network	2369
4	current	13180	54	transformer	2170
5	circuit	11444	55	field	2163
6	system	8884	56	equations	2162
7	phase	7207	57	case	2150
8	shown	6266	58	gain	2121
9	time	6192	59	currents	2107
10	line	6159	60	determine	2083
11	frequency	6141	61	maximum	2071
12	used	6030	62	response	2070
13	load	5754	63	applications	2064
14	signal	5748	64	devices	2026
15	output	5327	65	parallel	2015
16	input	5195	66	rotor	2002
17	given	5174	67	set	1983
18	systems	4841	68	information	1981
19	resistance	4657	69	voltages	1978
20	electrical	4654	70	find	1965
21	source	4496	71	noise	1960
22	value	4139	72	table	1933
23	solution	4138	73	torque	1892
24	energy	4023	74	conductor	1891
25	between	3963	75	small	1884
26	transmission	3955	76	large	1875
27	high	3803	77	device	1873
28	using	3783	78	across	1858
29	control	3744	79	components	1847
30	data	3718	80	consider	1845
31	function	3626	81	operation	1832
32	equation	3618	82	machine	1829

33	motor	3547	83	model	1815
34	circuits	3333	84	rate	1814
35	press	3275	85	computer	1798
36	magnetic	3265	86	capacitor	1786
37	electric	3222	87	lines	1773
38	series	3092	88	diagram	1768
39	speed	3034	89	total	1760
40	state	2932	90	transfer	1756
41	design	2908	91	applied	1747
42	connected	2842	92	signals	1691
43	engineering	2802	93	coil	1680
44	analysis	2771	94	unit	1679
45	low	2699	95	angle	1678
46	equivalent	2603	96	fault	1669
47	constant	2600	97	based	1669
48	impedance	2541	98	linear	1624
49	values	2514	99	temperature	1613
50	factor	2480	100	supply	1610

Here's the categorized list of words based on parts of speech like nouns, verbs, adjectives, adverbs, prepositions, conjunctions, and pronoun.

Nouns: voltage, figure, power, current, circuit, system, phase, time, line, frequency, load, signal, output, input, systems, resistance, source, value, solution, energy, transmission, control, data, function, equation, motor, circuits, press, speed, state, design, engineering, analysis, impedance, values, factor, point, network, transformer, field, equations, case, gain, currents, response, applications, devices, rotor, set, information, voltages, noise, table, torque, conductor, device, components, operation, machine, model, rate, computer, capacitor, lines, diagram, transfer, signals, coil, unit, angle, fault, temperature, supply, sequence, wave, option, range, terms, armature, loss, loop, process, step, logic, level, pole, generator, ground, gate, book, winding, section, part, ratio, end, direction, magnitude, application, charge, length, diode, method, sources, area, switch, functions, capacitance, performance, memory, component, elements, channel, induction, problem, conductors, inductance, bit, flux, bus, characteristics, note, base, side, core, node, error, stator, distribution, result, parameters, average, effect, results, question, peak, processing, region, terminals, material, types, conditions, cost, amplifier, density, resistor, light, terminal, code, reference,

machines, mode, reactance, equipment, phasor, frequencies, air, element, technology, motors, page, techniques, shunt, wire, db, materials, means, surface, block, characteristic, bandwidth, transistor, problems, matrix, space, feedback, program, emf, hand, world, path, pulse, force, switching, pass, vector, transformers, battery, need, software, capacitors, size, times, communication, units, converter, electronics, approach, methods, theory, way, semiconductor, law, work, expression, domain, flow, product, amplitude, transform, waveform, effects, khz, formula, amplifier, cable, difference, models, points, answer, poles, vol, modulation, back, structure, turns, distance, fourier, particular, carrier, rpm, junction, inputs, lead, speech, addition, service, cycle, period, thermal, connection, delta, filter, states, communications, generation, amp, changes, cell, measurement, probability, bits, inductor, axis, disp, condition, binary, reliability, antenna, cross, layer, gap, protection, resistors, storage, examples, excitation, fact, spectrum, kva, dielectric, conversion, rad, medium, resistances, drop, stability, variables, electrons, turn, introduction, emitter, capacity, flux, development, diodes, radio, requirements, image, pressure, water, heat, september, bias, measure, access, simulation, symbol, copper, receiver, integrated, clock, slip, volt, technique, flow, neutral, cells, earth, trans, branch, representation, delay, rating, square, silicon, transistors, cause, combination, distortion, location, relay, sampling, sensors, electron, mesh, plane, curve, fields, velocity, amount, parts, questions, words, insulation, log, shift, register, sample, paper, meter, place, self, demand, loads, generators, cases, limit, coils, metal, numbers, plot, word, impulse, quality, references, appendix, true, computers, failure, relationship, station, efficiency, user, interference, hall, individual, propagation, solid, factors, research, faults, parameter, address, interface, safety, university, sensor, exercise, switches, tan, wires, construction, drain, respect, iron, mean, practice, areas, converters, matlab, max, contact, standards,

mass, algorithm, discussion, coupling, fiber, array, original, display, polar, principle, sign, gates, impedances, inverter, stage, theorem, carry, hardware, outputs, harmonic, class, purpose, star, structures, concepts, nodes, notice, programs, thévenin, unity, study, cables, waves, chip, draw, center, engineers, leakage, port, causes, overhead, language, concept, regulation, strength, saturation, blocks, coding, sec, interval, instruction, grid, net, principles, environment, link, motion, quantity, years, pair, collector, opposite.

Verbs: shown, used, given, press, connected, determine, find, consider, applied, should, shows, being, change, provide, made, assume, controlled, does, let, follows, obtain, developed, had, pass, induced, need, do, having, find, approach, work, expressed, increase, sum, were, associated, include, answer, determined, write, reduced, increases, needed, represented, becomes, calculate, modified, make, defined, could, gives, generated, illustrated, provides, measured, consists, proportional, produce, get, reduce, described, seen, present, requires, assuming, considered, desired, balanced, rotating, cannot, produced, discussed, written, increased, occurs, leads, provided, referred, taken, including, substituting, represent, require, contains, applying, operate, complete, transmitted, assumed, depends, delivered, compared, placed, solve, uses, increasing, occur, excited, apply, start, better, show, depending, compute, achieved, selected, allows, supplied, produces, receiving, shall, added.

Adjectives: electrical, magnetic, electric, series, low, equivalent, constant, digital, small, large, total, linear, basic, common, equal, positive, known, open, short, synchronous, general, negative, operating, different, full, real, possible, complex, ideal, important, below, higher, typical, either, another, primary, potential, various, electronic, long, first, standard, simple, variable, rated, mechanical, corresponding, closed, active, physical, four, half, differential, direct, induced, minimum, secondary, helpful,

related, optical, main, initial, lower, continuous, independent, similar, further, particular, practical, reactive, reduced, needed, thermal, modified, necessary, useful, electromagnetic, proportional, good, nonlinear, certain, greater, internal, multiple, larger, balanced, actual, transient, additional, relative, effective, free, normal, clear, periodic, reverse, special, dependent, few, limited, wide, major, random, overall, complete, fundamental, smaller, inductive, rather, discrete, relatively, best, excited, original, critical, every, harmonic, capacitive, resonant, local, specific, approximate, coupled, leading, top, operational, resistive, opposite.

Adverbs: between, high, using, often, directly, just, here, without, typically, before, back, right, along, always, well, under, off, first, how, respectively, simply, commonly, approximately, together, sometimes, furthermore, generally, due, now, above, really, after, either, likewise, rather, easily, later, particularly, mostly, anywhere, around, down.

Prepositions: between, across, based, for, without, along, under, about, below, after, either, due, during, within, around.

Conjunctions: whether, either.

Pronouns/Determiners: your, them, those, another.

Among the top-ranking nouns were voltage, figure, power, current, circuit, system, phase, time, line, frequency, load, and signal. These terms appeared consistently across chapters and books, indicating their role as core concepts in the field. For instance, the noun voltage occurred more than 14,091 times across the corpus, followed closely by figure, power and current, reflecting their fundamental place in both theoretical explanations and problem-solving contexts.

The list of high-frequency verbs included shown, used, given, press, connected, determine, find, and consider. These verbs typically describe actions or processes associated with electrical phenomena or

procedures.

High-frequency adjectives were also observed, such as electrical, magnetic, electric, series, low, equivalent, and constant. These modifiers often serve to qualify measurements or distinguish between states or values within a system (e.g., electric current, low resistance, constant voltage), again reinforcing their importance in descriptive and explanatory language.

3.2 Collocations

In addition to individual word frequency, collocational patterns were analyzed using AntConc's Collocates tool, with a five-word span set around key node words. The analysis revealed discipline-specific collocations and lexical bundles that are highly recurrent across the corpus. Among the most notable were voltage source, voltage drop, voltage circuit, output voltage, voltage gain, shown in the figure, the figure shows, the figure illustrates, typical figure, current source, alternating current, current load, current flow, direct current, current fault, inductor current, equivalent circuit, short circuit, open circuit, circuit breaker and series circuit.

For example, the term voltage frequently co-occurred with words like drop, source, value, and across, producing common collocational frames such as voltage drop across the resistor or the value of the voltage source. Similarly, circuit often appeared in phrases like circuit diagram, closed circuit, and series circuit—all of which are fundamental in electrical systems description and analysis.

Lexical bundles such as “as shown in Figure”, “in this circuit”, and “the figure illustrates” were also identified using the Clusters/N-Grams tool. These bundles frequently function as discourse markers and instructional signals, aiding the reader in following the logic of explanations or locating figures and data. For instance, as shown in Figure was often used to reference visual aids accompanying descriptions, while the value of frequently preceded a calculation or measurement.

Quantitative summaries of these

collocational patterns showed that some combinations occurred hundreds of times across multiple books, suggesting their conventional status within the genre of engineering textbooks. The consistency of these patterns across different publishers and subtopics (e.g., basic electronics, control systems, and power engineering) further underscores their instructional and communicative importance.

Taken together, the frequency and collocation results illustrate the lexical density and repetition characteristic of electrical engineering discourse. The results offer a solid empirical foundation for ESP vocabulary selection, textbook enhancement, and corpus-informed teaching practices.

4. Discussion

The findings of this study offer substantial insights into the lexical and phraseological characteristics of electrical engineering discourse as represented in 15 widely used textbooks. The analysis of the 100 most frequent words supports the previous study by Botchwey et al., 2024 that the most distinctive recurring register or vocabulary used in the selected textbooks includes technical terms like current, electric, voltage, field, circuit, figure, and power.

One of the most prominent observations is the overwhelming dominance of nouns in the most frequent word list. Words such as voltage, figure, power, current, and circuit—which top the frequency rankings—are not merely common; they function as core conceptual anchors within the discipline. This aligns with previous findings in English for Specific Purposes (ESP) research, where subject-specific nouns often constitute the bulk of specialized vocabulary (Hyland, 2009). The high recurrence of these terms across various textbooks and subdomains suggests that any ESP course design or technical writing instruction for engineering students should prioritize these high-frequency lexical items.

The noun figure ranking second in frequency—surpassing even current and circuit—indicates the crucial multimodal nature of engineering texts. This reinforces the argument by Lemke (1998), who emphasizes

that meaning in scientific discourse is not conveyed solely through words but through tightly integrated verbal-visual modes, including diagrams, graphs, and circuit schematics. As such, phrases like “as shown in Figure” and “the figure illustrates” act as discourse signals guiding the reader’s navigation through the text and accompanying visuals.

In terms of verbs, the dominance of terms such as shown, used, given, connected, and determine reveals the procedural and descriptive character of technical writing. These verbs often function in the passive voice, reflecting an impersonal and objective tone typical of academic engineering prose (Swales & Feak, 2012). For example, the phrase “the voltage is shown in Figure 2” typifies the genre’s tendency to depersonalize the agent, focusing instead on the phenomena being described. This linguistic strategy reinforces the scientific ethos of neutrality and objectivity.

Adjectives such as electrical, magnetic, equivalent, and constant also appear with high frequency, typically modifying key nouns to introduce specificity. The phrases electrical circuit, constant voltage, or equivalent resistance illustrate how adjectives in engineering texts contribute to semantic precision and categorical clarity, features that are essential in a field where misinterpretation can lead to critical design or analytical errors (Biber et al., 1999).

The collocation analysis further enriches our understanding of how technical meaning is constructed in context. Collocations like voltage drop, current flow, short circuit, and power supply reflect conceptual chunking in engineering discourse—linguistic units that are not random but rather semantically cohesive and contextually bound. These frequent co-occurrences are not only lexically predictable but also cognitively entrenched in the minds of both writers and readers in this field (Sinclair, 1991). Their repeated use may assist learners in acquiring domain-specific fluency and reading comprehension, as they encapsulate complex concepts into manageable multiword expressions.

The presence of lexical bundles (e.g., “in

this circuit”, “as shown in Figure”, “the value of”) demonstrates the formulaic nature of academic writing in engineering. These bundles serve both rhetorical and structural functions: they help frame arguments, introduce figures, and set up calculations. As such, their pedagogical value is immense. As Biber, Conrad, and Cortes (2004) argue, mastering such bundles is essential for learners to achieve disciplinary fluency and to write in a way that is recognizable and acceptable within the target academic community.

Another point of interest is the overlap between frequently used words and collocations across sub-disciplines, such as electronics, power systems, and control engineering. Despite the variety of textbooks analyzed, there is a remarkable lexical uniformity, suggesting that the language of electrical engineering maintains a consistent set of core concepts and expression patterns across different areas. This consistency may simplify the task of ESP material developers, who can confidently build vocabulary resources around a relatively stable set of high-utility terms.

Furthermore, the frequency of measurement-related terms (e.g., frequency, load, resistance, value, gain) reflects the field’s quantitative orientation. These words frequently appear with verbs like determine, calculate, and find, indicating that much of the discourse revolves around problem-solving and analysis. This aligns with the work of Nation (2001), who stresses the importance of selecting high-frequency, discipline-relevant vocabulary for ESP learners involved in technical education.

In summary, the results confirm the lexical density, repetition, and formulaicity that characterize electrical engineering discourse. These features suggest a clear pedagogical path for ESP curriculum designers, textbook authors, and instructors, who can base their materials on empirical corpus findings to support students’ academic literacy in engineering.

5. Conclusion

This study, through a comprehensive corpus-based analysis of 15 electrical

engineering textbooks, has provided significant insights into the lexicogrammatical features that characterize this specialized discourse. Our findings confirm the prominent role of specific nouns like voltage, figure, power, current, and circuit as fundamental conceptual anchors, appearing with exceptionally high frequencies. Similarly, recurrent verbs such as shown, used, given, and determine highlight the procedural and descriptive nature of engineering texts, often presented in an objective, impersonal tone. The prevalence of modifying adjectives like electrical, magnetic, and constant further underscores the need for semantic precision in conveying technical specifications. These results collectively answer our first research question, demonstrating a distinct lexical profile that is highly consistent with the core concepts and communicative demands of electrical engineering.

Beyond individual word frequencies, the analysis of collocational patterns and lexical bundles provided a deeper understanding of how meaning is constructed in context. Common collocations such as voltage drop, current flow, and short circuit, along with formulaic expressions like "as shown in Figure" and "in this circuit," reveal the conventional and chunked nature of engineering language. These multiword units are not merely incidental but represent established cognitive and linguistic structures that streamline communication and comprehension within the discipline. The consistent appearance of these patterns across diverse textbooks and sub-disciplines underscores their communicative importance and provides a clear answer to our second research question regarding common lexical collocations.

In conclusion, the empirical evidence gathered from this corpus study strongly supports the notion of a distinct and remarkably stable linguistic register in electrical engineering textbooks. The identified high-frequency vocabulary, significant nouns, verbs, adjectives, and recurrent collocations and lexical bundles

offer a strong foundation for developing targeted English for Specific Purposes (ESP) curricula. By prioritizing these empirically derived linguistic features, educators and material designers can significantly enhance the academic literacy of engineering students, equipping them with the precise language tools necessary to navigate, comprehend, and produce effective technical discourse. Future research could explore the pedagogical implications of these findings through intervention studies, assessing the impact of corpus-informed materials on student learning outcomes in electrical engineering.

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