UNDERGRADUATE CURRICULUM (AUTONOMOUS INSTITUTION)

Programme: B. E Elecrical and Electronics Engineering **Regulations**: 2026

List of Abbreviations

HUM - Humanities (Languages, Management, Heritage, and others)
BS - Basic Science (Mathematics, Physics, Chemistry)
ES - Engineering Science (General (G), Programme Core (PC), Programme Elective (PE) & Emerging Technology (ET))
SD - Skill Development
SL - Self-Learning
CDP - Capstone Design Project
TCP - Total Contact Period(s)
OE - Open Elective
L - Laboratory Course
T - Theory
DIC - Department Introductory Course
LIT - Laboratory Integrated Theory
PW - Project Work
IPW - Internship cum Project Work

SEMESTER-I								
S. No.	**Course Code**	**Course Title**	**Category**	**TCP**	**L**	**T**	**P**	**Credits**
		Induction Program – Universal Human Values	VAC					
Theory								
1	26MA1T01	Matrices and Calculus	BS	4	3	1	0	4
2	26TA1T01	தமிழர் மரபு / Heritage of Tamils	HUM	1	1	0	0	1
3	26EN1T01	Communicative English	HUM	2	2	0	0	2
Laboratory Integrated Theory (LIT)								
4	26PH1I01	Physics for Modern Engineering	BS	4	2	0	2	3
5	26CY1I01	Applied Chemistry for Engineers	BS	4	2	0	2	3
6	26CS1I03	Essentials of Computing and C Programming	ES(G)	4	2	0	2	3
7	26ME1I02	Engineering Graphics and Design	ES(G)	5	1	2	4	2
Laboratory Courses								
8	26ME1L01	Makerspace	SD	4	0	0	4	2
Life Science								
9	26LS1S01	Life Skills for Engineers – I	HUM	3	1	0	2	1
10	26LS1S02	Physical Education – I	HUM	4	0	0	4	1
11	—	NCC / NSS / NSO						
TOTAL				**35**	**14**	**1**	**20**	**23**

INDUCTION PROGRAMME

Introduction

The Student Induction Programme, as recommended by All India Council for Technical Education (AICTE), is incorporated as an essential component in the curriculum to facilitate the smooth transition of newly admitted students into the engineering education system. It aims to orient students towards academic requirements, institutional practices, and professional expectations.

Objectives of the Programme

The programme is designed to promote holistic development by integrating academic orientation with activities related to skill development, ethical values, physical well-being, and social awareness. It also fosters interaction among students and faculty, encourages self-exploration, and helps in developing discipline, responsibility, and a positive attitude towards learning and professional growth.

Topics Covered

The following topics and activities are included in the Induction Programme to ensure the overall development of students in accordance with the guidelines of All India Council for Technical Education.

1. Tips for Engineering Studies

This topic helps students adapt to engineering learning methods and academic expectations. It encourages effective study habits and self-learning practices.

2. The Importance of Engineering in Society

This topic creates awareness about the role of engineering in societal development. It motivates students to contribute to national and global needs.

3. How to Prepare for Engineering Examinations

This topic reduces exam fear and builds confidence in students. It promotes stress management and systematic preparation.

4. Perspectives of Engineering Students

This topic encourages self-expression and sharing of ideas. It helps students explore their interests and mindset.

5. Goal Setting and Implementation

This topic guides students to set clear academic and personal goals. It develops planning and execution skills.

6. Technical & Analytical Skills for Engineers

This topic enhances logical thinking and problem-solving ability. It builds a strong technical foundation.

7. Professional Ethics

This topic develops moral values and ethical responsibilities. It prepares students to act responsibly in professional life.

8. Mathematical Ability is Important for Engineers

This topic strengthens understanding of core mathematical concepts. It supports analytical and engineering applications.

9. English Writing & Communication

This topic improves written communication skills. It helps in expressing ideas clearly and effectively.

10. Time Management

This topic encourages planning and prioritizing tasks. It helps maintain a balanced academic routine.

11. Professional English Conversation Practice

This topic develops confidence in speaking English. It enhances interpersonal communication skills.

12. Employability and Interview Management

This topic prepares students for job opportunities and interviews. It builds confidence and professional readiness.

13. Basic Science for Engineering

This topic connects science fundamentals with engineering concepts. It strengthens core subject understanding.

14. Curriculum & Syllabus

This topic familiarizes students with course structure and subjects. It helps them plan their academic journey.

15. JRF, GATE, NET – Importance

This topic creates awareness about higher studies and competitive exams. It encourages long-term academic goals.

16. Project Management & Teamwork

This topic promotes collaboration and group learning. It develops leadership and coordination skills.

17. Training and Placement

This topic provides insight into career opportunities. It prepares students for industry expectations.

18. Basic Guidelines of Our Campus

This topic helps students understand campus rules and culture. It ensures a comfortable and disciplined environment.

19. Social Responsibilities

This topic develops awareness of societal needs and responsibilities. It encourages ethical and community-oriented behavior.

20. Laboratory Safety Precautions and Procedures

This topic ensures safe handling of equipment and materials. It builds responsibility in laboratory practices.

21. Using Library Resources Effectively

This topic encourages the use of library resources for self-learning. It promotes reading and research habits.

22. Assessment & Evaluation

This topic clarifies evaluation methods and grading systems. It reduces confusion and builds transparency.

23. Office Management in Our College

This topic familiarizes students with administrative processes. It helps them access institutional support services.

24. Use of Social Media and Awareness

This topic promotes responsible and ethical use of social media. It creates awareness about digital safety.

25. A Tour of the College Campus

This topic helps students explore campus facilities. It builds comfort and connection with the institution.

26. Know Your Scholarships

This topic creates awareness about financial aid opportunities. It encourages students to utilize support schemes.

27. Yoga

This topic promotes physical and mental well-being. It helps in stress management and concentration.

28. Sports

This topic encourages physical fitness and teamwork. It builds discipline and bonding among students.

29. Healthy Lifestyle – Nutrition

This topic creates awareness about healthy food habits. It supports overall physical and mental health.

30. Creative and Participative Activities

This activity involves quizzes, group discussions, collage making, and mini projects to actively engage students. It promotes interaction, teamwork, creativity, and overall personality development without formal assessment.

The Induction Programme is activity-based and does not include formal examinations or assessments. It emphasizes participation, interaction, and experiential learning.

26MA1T01	MATRICES AND CALCULUS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES	
1	To develop the use of matrix algebra techniques that are needed by engineers for practical applications.
2	To provide a strong foundation in differential calculus.
3	To familiarize the student with functions of several variables used in engineering applications.
4	To enable students to understand and apply various techniques of integral calculus.
5	To develop the ability to evaluate multiple integrals and apply them to engineering problems.

UNIT I MATRICES	**12**
Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley–Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms. **Activities:** Diagonalization of matrices and reduction of quadratic forms to canonical form using open-source software; solving competitive examination questions (e.g., GATE).	
UNIT II DIFFERENTIAL CALCULUS	**12**
Representation of functions – Graph of functions – Limit of a function – Continuity – Limits at infinity – Derivative as a function – Mean value theorem – Maxima and minima of functions of a single variable. **Activities:** Visualization of functions, maxima and minima using open-source software; solving competitive examination questions (e.g., GATE).	
UNIT III FUNCTIONS OF SEVERAL VARIABLES	**12**
Partial derivatives – Chain rule – Total derivative – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers. **Activities:** Partial derivatives with two or three variables, maxima and minima using open-source software; solving competitive examination questions (e.g., GATE).	
UNIT IV INTEGRAL CALCULUS	**12**
Fundamental theorem of calculus – Indefinite integrals – Net change theorem – Improper integrals – Arc length – Area of region – Area of surface of revolution. **Activities:** Definite and indefinite integrals, determination of area; solving competitive examination questions (e.g., GATE).	

UNIT V MULTIPLE INTEGRALS	12
Evaluation of double integrals – Change of order of integration – Change of variables between Cartesian and polar coordinates – Evaluation of triple integrals – Change of variables between Cartesian and cylindrical and spherical coordinates. Activities: Double and triple integrals using open-source software; solving competitive examination questions (e.g., GATE).	
TOTAL PERIODS	**60**

COURSE OUTCOMES	
At the end of the course, the student will be able to:	
CO1	Use matrix algebra methods for solving practical problems.
CO2	Apply differential calculus tools in solving various application problems.
CO3	Use differential calculus ideas on several-variable functions.
CO4	Apply different methods of integration in solving practical problems.
CO5	Apply concepts of multiple integrals to find areas, volumes and other practical problems.
TEXT BOOKS	
1	Kreyszig, E., Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, New Delhi, 2016.
2	Grewal, B. S., Higher Engineering Mathematics, 44th Edition, Khanna Publishers, New Delhi, 2018.
3	James Stewart, Calculus: Early Transcendentals, 8th Edition, Cengage Learning, New Delhi, 2015. [For Units II & IV: Sections 1.1, 2.2, 2.3, 2.5, 2.7 (tangent problems only), 2.8, 3.1–3.6, 3.11, 4.1, 4.3, 5.1 (area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1–7.4 and 7.8.]
4	Anton, H., Bivens, I. C., and Davis, S., Calculus: Early Transcendentals, John Wiley & Sons, 2021.
REFERENCES	
1	Thomas, G. B., Hass, J., and Weir, M. D., Thomas' Calculus, 14th Edition, Pearson India, 2018.
2	Narayanan, S., and Manicavachagom Pillai, K., Calculus, Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
3	Ramana, B. V., Higher Engineering Mathematics, McGraw Hill Education Pvt. Ltd., New Delhi, 2016.

4	Bali, N., Goyal, M., and Watkins, C., Advanced Engineering Mathematics, 7th Edition, Firewall Media (an imprint of Lakshmi Publications Pvt. Ltd.), New Delhi, 2009.
5	Jain, R. K., and Iyengar, S. R. K., Advanced Engineering Mathematics, 5th Edition, Narosa Publications, New Delhi, 2016.
6	Srimantha Pal and Bhunia, S. C., Engineering Mathematics, Oxford University Press, 2015.
E-RESOURCES	
1	https://math.libretexts.org/Bookshelves/Calculus/Map%3A_Calculus__Early_Transcendentals_%28Stewart%29/
2	https://openstax.org/books/calculus-volume-1/
3	https://tutorial.math.lamar.edu/Classes/CalcII/CalcII.aspx
4	SCILAB – https://www.scilab.org/

CO/PO/PSO Mapping

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2	PSO 3
CO1	3	3	1	1	2		-	-	-	-	1	2	3	1
CO2	3	3	1	2	2	-	-	-	-	-	1	2	3	1
CO3	3	3	2	2	2	-	-	-	-	-	1	2	3	1
CO4	3	3	2	2	2	-	-	-	-	-	1	2	3	1
CO5	3	3	2	3	2	-	-	-	-	-	1	2	3	1
AVG	3	3	1.6	2	2	-	-	-	-	-	1	2	3	1

26TA1T01	தமிழர் மரபு	L	T	P	C
		1	0	0	1
அலகு 1: மொழி மற்றும் இலக்கியம்					3
இந்திய மொழிக் குடும்பங்கள் மற்றும் திராவிட மொழிகள், தமிழ் ஒரு செம்மொழி, தமிழ் செவ்விலக்கியங்கள், சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை, சங்க இலக்கியத்தில் பகிர்தல் அறம், திருக்குறளில் மேலாண்மைக் கருத்துக்கள், தமிழ்க் காப்பியங்கள் மற்றும் தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம், பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள், சிற்றிலக்கியங்கள், தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி, தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.					
அலகு 2: மரபு மற்றும் கலைகள்					3
பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை – சிற்பக்கலை: நடுகல் முதல் நவீன சிற்பங்கள் வரை, ஐம்பொன் சிலைகள், பழங்குடியினர் மற்றும் அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள், பொம்மைகள், தேர் செய்யும் கலை, சுடுமண் சிற்பங்கள், நாட்டுப்புறத் தெய்வங்கள் மற்றும் குமரிமுனையில் திருவள்ளுவர் சிலை, இசைக் கருவிகள், மிருதங்கம், பறை, வீணை, யாழ் மற்றும் நாதஸ்வரம், தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.					
அலகு 3: நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள்					3
தெருக்கூத்து, கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து மற்றும் ஒயிலாட்டம், தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி மற்றும் புலியாட்டம், தமிழர்களின் ஏனைய விளையாட்டுகள்.					
அலகு 4: தமிழர்களின் திணைக் கோட்பாடுகள்					3
தமிழகத்தின் தாவரங்களும், விலங்குகளும், தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள், தமிழர்கள் போற்றிய அறக்கோட்பாடு, சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும், சங்ககால நகரங்கள், துறைமுகங்கள், ஏற்றுமதி மற்றும் இறக்குமதி, கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.					

அலகு 5: இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு	**3**
இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு, இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் மற்றும் சுயமரியாதை இயக்கம், இந்திய மருத்துவத்தில் சித்த மருத்துவத்தின் பங்கு, கல்வெட்டுகள், கையெழுத்துப்படிகள் மற்றும் தமிழ்ப் புத்தகங்களின் அச்சு வரலாறு.	
TOTAL PERIODS	**15**

REFERENCES	
1	தமிழக வரலாறு, மக்களும் பண்பாடும், கே.கே. பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித் தமிழ், முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3	கீழடி, வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு).
4	பொருநை, ஆற்றங்கரை நாகரிகம் (தொல்லியல் துறை வெளியீடு).
5	Social Life of Tamils (Dr. K. K. Pillay), a joint publication of TNTB & ESC and RMRL (in print).
6	Social Life of the Tamils: The Classical Period (Dr. S. Singaravelu), published by the International Institute of Tamil Studies.
7	Historical Heritage of the Tamils (Dr. S. V. Subatamanian and Dr. K. D. Thirunavukkarasu), published by the International Institute of Tamil Studies.
8	The Contributions of the Tamils to Indian Culture (Dr. M. Valarmathi), published by the International Institute of Tamil Studies.
9	Keeladi: Sangam City Civilization on the Banks of River Vaigai, jointly published by the Department of Archaeology and Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu.
10	Studies in the History of India with Special Reference to Tamil Nadu (Dr. K. K. Pillay), published by the author.
11	Porunai Civilization, jointly published by the Department of Archaeology and Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu.
12	Journey of Civilization: Indus to Vaigai (R. Balakrishnan), published by RMRL – Reference Book.

26EN1T01	COMMUNICATIVE ENGLISH	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES	
1	To improve the communicative competence of learners.
2	To learn to use basic grammatical structures in suitable contexts.
3	To acquire lexical competence and use words appropriately in a sentence and understand their meaning in a text.
4	To help learners use language effectively in professional contexts.
5	To develop learners' ability to read and write complex texts, summaries, articles, blogs, definitions and essays.

UNIT I FUNDAMENTALS OF COMMUNICATION & SELF-EXPRESSION	**6**
Reading – Short comprehension passages, short technical/social media messages. Writing – Introducing oneself, informal email/letter, completing sentences, developing hints into sentences, paragraph writing (topic sentence and main idea). Grammar – Present tense (simple and progressive), Wh-questions, Yes/No questions, question tags, parts of speech. Vocabulary – Prefixes and suffixes, synonyms and antonyms, abbreviations and acronyms. **Activities:** Self-introduction, developing a story using hints.	
UNIT II NARRATION & GENERAL READING	**6**
Reading – Biographies, travelogues, newspaper reports. Writing – Guided paragraph writing, short report writing (events/field visit), narrative writing. Grammar – Past tense (simple), subject–verb agreement, prepositions, degrees of comparison. Vocabulary – Word forms, phrasal verbs. **Activities:** Preparing news reports, reports on field visit.	
UNIT III PROCESS & PRODUCT DESCRIPTION	**6**
Reading – Advertisements, product descriptions. Writing – Writing definitions, instructions, product/process description, dialogue writing. Grammar – Imperatives, adjectives, present and past perfect tenses, pronouns. Vocabulary – Homonyms and homophones, discourse markers. **Activities:** Describing products, dialogue writing.	
UNIT IV REPORTING OF EVENTS AND RESEARCH	**6**
Reading – Newspaper articles, journal reports. Writing – Note-making/note-taking, writing recommendations, report writing (accident, feasibility and survey). Grammar – Articles, relative and possessive pronouns. Vocabulary – Fixed and semi-fixed expressions. **Activities:** Journal reports, report writing, letter writing.	

UNIT V EXTENDED WRITING & PROFESSIONAL EXPRESSION	6
Reading – Editorials, opinion blogs, longer academic texts. Writing – Essay writing (descriptive/narrative), identifying main and subordinate ideas. Grammar – Future tenses, punctuation, negation. Vocabulary – Cause-and-effect expressions. **Activities:** Essay writing.	
TOTAL PERIODS	**30**

COURSE OUTCOMES	
At the end of the course, the student will be able to:	
CO1	Develop communication skills relevant to engineering and technology.
CO2	Read and comprehend different types of texts—including narrative, descriptive, technical and analytical—using appropriate reading strategies.
CO3	Write coherent paragraphs, reports, emails, process descriptions and essays using appropriate structure and organization.
CO4	Apply grammatical structures, such as tenses, pronouns, modals and various sentence types, accurately in written communication.
CO5	Use appropriate vocabulary in context, including technical terms, collocations, phrasal verbs and discourse markers.
TEXT BOOKS	
1	Board of Editors, Using English: A Coursebook for Undergraduate Engineers and Technologists, Orient BlackSwan Limited, Hyderabad, 2015.
2	Richards, C. Jack, Interchange Students' Book 2, New Delhi: CUP, 2015.
REFERENCES	
1	Bailey, Stephen, Academic Writing: A Practical Guide for Students, New York: Routledge, 2011.
2	Means, L. Thomas, and Elaine Langlois, English & Communication for Colleges, Cengage Learning, USA, 2007.
3	Redston, Chris, and Gillies Cunningham, Face2Face (Pre-intermediate Student's Book & Workbook), Cambridge University Press, New Delhi, 2005.
4	Comfort, Jeremy, et al., Speaking Effectively: Developing Speaking Skills for Business English, Cambridge University Press, Cambridge, reprint 2011.
5	Dutt, P. Kiranmai, and Geeta Rajeevan, Basic Communication Skills, Foundation Books, 2013.

CO/PO/PSO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO2	PSO3
CO 1	-	-	-	-	-	-	-	-	2	-	1	-	-	3
CO 2	-	2	-	-	-	-	-	-	2	-	2	-	1	-
CO 3	-	-	-	-	-	-	-	-	2	-	1	-	-	2
CO 4	3	-	-	-	-	-	-	-	3	-	2	2	-	3
CO 5	3	-	-	-	-	-	-	-	3	-	1	2	-	3
AVG	3	2							2.4		1.4	2	1	2.7

26PH1I01	PHYSICS FOR MODERN ENGINEERING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES	
1	Develop analytical understanding of rigid body mechanics and material elasticity relevant to engineering structures.
2	Introduce electromagnetic waves' behaviour and their applications
3	Provide knowledge of Heat transfer concepts and ultrasonic production methods.
4	Explain laser physics applications and fibre-optic communication technologies.
5	Apply quantum mechanics concepts to nanoscale and electronic systems.

Unit I MECHANICS AND PROPERTIES OF MATTER	**9**
Center of mass and motion of CM- kinetic energy of a system of particles- moment of inertia and theorems of M.I.; M.I. of continuous bodies (ring, disc)- conservation of angular momentum; gyroscope. Elasticity: Hooke's law- stress–strain diagram- factors affecting elasticity- bending of beams- Young's modulus by uniform and non-uniform bending – Cantilever- Torsional pendulum. **Activities:** Virtual demonstration of the Moment of Inertia of a Disc. **Practical:** Simple harmonic oscillations of a cantilever, Uniform bending – Determination of Young's modulus.	
Unit II ELECTROMAGNETIC WAVES	**9**
The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, - properties of electromagnetic waves: speed, amplitude, phase, - Energy and momentum in EM waves: - Electromagnetic spectrum- Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium vaccum interface for normal incidence. **Activities**: Virtual demonstration of propagation of EM waves **Practical:** Melde's string experiment – Frequency of an electrically vibrating	
Unit III ULTRASONICS	**9**
Ultrasonics: Production of ultrasonic waves – Piezoelectric effect – piezoelectric generator – Properties of ultrasonic waves – Detection of ultrasonic waves - Acoustic grating- Non-Destructive Testing (pulse-echo system, transmission & reflection modes)-SONAR. **Activities:** Virtual Demonstration of the Piezoelectric effect. **Practical:** Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids	
Unit IV LASE	**9**
Laser characteristics: spontaneous and stimulated emission; Einstein coefficients; population inversion. Types of lasers: Nd:YAG laser, CO_2 laser, semiconductor lasers (homojunction & heterojunction). Industrial and medical applications. Fibre optics:	

Principle- numerical aperture- acceptance angle- types of fibres (material, refractive index, and mode. Fibre-optic communication system (block diagram) - displacement sensors- temperature & pressure sensors. **Activities:** Demonstration of sensors and applications of Lasers. **Practical:** Determination of the wavelength of the laser using a grating, Optical fibre – Determination of Numerical Aperture and acceptance angle	
Unit V QUANTUM MECHANICS	**9**
Planck's quantum theory- photoelectric effect -matter waves-wave function- Schrödinger equation (time-dependent & independent) - Particle in infinite potential well (1D, 3D boxes). Scanning tunnelling microscope - Bloch's theorem for Particle in Periodical Potential- basics of Kronig–Penney model. Activities: Virtual demonstration of Scanning Transmission Electron Microscope Practical: Ruling width of Compact disc using Laser, Photoelectric Effect, Determination of Planck's constant	
TOTAL PERIODS	**45**

COURSE OUTCOMES	
At the end of the course, the student will be able to	
CO1	Understand the rigid body motion, inertia and elastic behaviour of materials in engineering systems
CO2	Analyse electromagnetic wave propagation, energy transport, and boundary reflection/transmission phenomena.
CO3	Determine thermal conductivity using experimental methods and explain ultrasonic generation and NDT applications.
CO4	Explain stimulated emission, differentiate laser types, and analyse fibre-optic communication parameters.
CO5	Solve Schrödinger equations for confined particles and interpret periodic potential models in solids.
TEXT BOOKS	
1	D. Kleppner and R. Kolenkow. An Introduction to Mechanics. McGraw Hill Education (Indian Edition), 2017.
2	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, Concepts of Modern Physics, McGraw – Hill (Indian Edition), 2017.
3	Gaur R.K. and Gupta S.L. Engineering Physics. Dhanpat Rai publishers, 2009.
4	Kasap, Safa, Capper, " Handbook of Electronic and Photonic Materials"2nd edition, Springer, 2017.
5	Eleanor Rleffel and Wolfgang Polak, "Quantum computing a gentle introduction", 1st edition, The MIT press,2012. Page 23 of 298

REFERENCES	
1	R. Wolfson. Essential University Physics. Volume 1 & 2. Pearson Education (Indian Edition),2009.
2	K. Thyagarajan and A. Ghatak. Lasers: Fundamentals and Applications, Laxmi Publications, (Indian Edition), 2019.
3	D. Halliday, R. Resnick and J. Walker. Principles of Physics, Wiley (Indian Edition), 2015.
4	Searls and Zemansky. University Physics, 2009.
5	David J. Griffiths, “Introduction to Quantum Mechanics”, 2nd edition , Cambridge university press, 2017. 6. Chris Bernhardt, “Quantum computing for everyone” The MIT press, 2019

CO/PO/PSO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	-	2	1	-	-	-	-	-	1	3	-	-
CO2	3	2	-	2	2	-	-	-	-	-	1	2	2	-
CO3	3	-	-	3	2	-	-	-	-	-	1	3	3	1
CO4	3	3	1	3	3	-	-	-	-	-	1	3	3	2
CO5	3	3	-	1	-	-	-	-	-	-	2	3	1	2
AVG	3	2	0.2	2.2	1.6	-	-	-	-	-	1.2	2.8	1.8	1

26CY1I01	APPLIED CHEMISTRY FOR ENGINEERS	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES	
1	To impart knowledge to the students on the basic concepts of water technology, treatment methods, and desalination processes.
2	Learn nanochemistry, including properties and applications of nanomaterials.
3	Study polymers and composite engineering materials and their uses.
4	Understand fuels, combustion principles, and alternative energy sources.
5	Gain knowledge of batteries and energy storage systems.

Unit I WATER TECHNOLOGY	**9**
Water quality parameters and standards, boiler troubles, Industrial feed water- internal and External treatment, Desalination process, Municipal water treatment. **Activity:** Coagulation of a water sample by using alum. **Practical:** Analysis of alkalinity, hardness and dissolved oxygen.	
Unit II NANOCHEMISTRY	**9**
Classification and properties of nanomaterials- synthesis of nanomaterial- Top-down and bottom-up approaches (sol-gel, solvothermal, electrospinning, laser ablation, CVD reactor), Applications of nanomaterials in various fields. **Activity:** Preparation of nanoparticles by the Sol-Gel method. **Practical:** Preparation of nanoparticles (TiO_2/ZnO/CuO) by the Sol-Gel method.	
Unit III ELECTROCHEMISTRY	**9**
Electrochemistry-Introduction-Cells and their types-emf series-Nernst equation and its applications. Reference electrodes: standard hydrogen electrode, redox reaction, saturated calomel electrode, glass electrode, pH measurement. **Activities:** Electrochemical cell demonstration **Practical:** Determination of the strength of given hydrochloric acid using a pH meter.	
Unit VI CORROSION CONTROL AND ALLOYS	**9**
Types: Dry-chemical corrosion and wet- galvanic and differential aeration (pitting, crevice, pipeline)- factors influencing rate of corrosion, corrosion control methods, sacrificial anode and impressed current method, protective coating- electroplating- Ni plating, Alloys- ferrous (stainless steel), heat treatment-nonferrous alloys (brass-dutch metal, german silver)-composition, properties and uses. **Activities:** Case Study on Corrosion in Pipelines and Electronics, Control measures for a corroded metal. **Practical:** Corrosion study by weight loss method.	
Unit V ENERGY STORAGE DEVICES	**9**
Introduction-Primary & Secondary Batteries- dry cell- alkaline battery-Pb- acid battery-Na-ion battery- Flow battery. Emerging trends of batteries: solid-state batteries, Silicon / Graphene Anode Batteries, Sulfur-Selenium Solid-State Batteries,	

Battery Pack, Battery Materials, Testing, Safety aspects. **Activities:** Demonstration on battery pack in e-vehicles. **Practical:** Measurement of EMF and Discharge Characteristics.	
TOTAL PERIODS	**45**

COURSE OUTCOMES	
At the end of the course, the student will be able to	
CO1	Students will be able to understand and evaluate water treatment and quality parameters.
CO2	Identify nanomaterials and explain their preparation techniques.
CO3	Classify engineering materials and relate them to applications.
CO4	Analyse fuels, combustion processes, and related calculations.
CO5	Compare batteries and assess their performance and safety.
TEXT BOOKS	
1	Jain & Jain, "Engineering chemistry", Dhanpat Rai Publishing Company (P) Ltd., New Delhi, 15th Edition, 2008.
2	T. Pradeep – Nano: The Essentials (Understanding Nanoscience & Nanotechnology) – A dedicated text on nanoscience principles and materials synthesis.
3	Energy storage devices- S.R Bakshi & O.P Malix.
4	Principles of Physical Chemistry By Puri Sharma and Pathania, Milestone Publishers.
REFERENCES	
1	Jain, P. C., & Jain, M. (2015). Engineering Chemistry (17th ed.). Dhanpat Rai Publishing Company (P)Ltd.
2	Dara, S. S. (2004). A Textbook of Engineering Chemistry. Chand Publications.
3	Sachdeva, M. V. (2011). Basics of Nano Chemistry. Anmol Publications Pvt Ltd. Friedrich, E. (2014). Engineering Chemistry. Medtech.
4	V.R Gowarikar, N.V Viswanathan and jayadev sreedhar, "polymer science, New age international P (Ltd)., Chennai.

CO/PO/PSO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	3	2	2	1	-	2	3	-	-	-	-	3	2	3
CO2	3	1	2	2	2	-	-	-	-	-	-	2	3	2
CO3	3	2	1	-	-	-	-	-	-	-	-	3	2	1
CO4	3	3	2	2	-	1	2	-	-	-	-	3	2	2
CO5	3	2	3	2	2	2	3	-	-	-	-	3	3	2
AVG	3	2	2	2	1.4	0.8	1	1.6	0	0	0	2.8	2.4	2.0

26CS1I03	ESSENTIALS OF COMPUTING AND C PROGRAMMING	L	T	P	C
		2	0	2	3

Course Objectives

1	To understand the fundamental concepts of computers, data representation, and basic data handling using office tools and spreadsheets
2	To develop computational thinking and problem-solving skills using number systems, logic, and algorithm design techniques.
3	To understand program development methods, design tools, and fundamental concepts of programming languages and paradigms.
4	To develop basic programming skills by creating interactive programs using Scratch with control structures and data handling.
5	To apply problem-solving techniques and modular design concepts in developing simple applications for real-world problems.

UNIT I COMPUTER BASICS

Computer, Characteristics of Computers, History of Computers, Classification of Computers, Applications of Computers, Basic Organization of a Computer. Data Representation, Using spread sheets for basic operations on data and visualize the data.

Practical:

Office Software for documentation and presentation Spread sheets for calculations and data. Visualization

UNIT II COMPUTATIONAL THINKING & PROBLEM-SOLVING BASICS

Computational Thinking, Decomposition, Abstraction and Real World Information to Computable Data, Number Systems, and Conversions among Number systems, what is Logic, Boolean Logic, Applications of Propositional Logic. Problem Definition, Logical Reasoning, Decomposition, Software Design Concept of an Algorithm, Algorithm Representation – Algorithm Discovery – Iterative Structures – Recursive Structures – Efficiency and Correctness - Implementation of Algorithms - Fundamental Algorithms: Exchanging the values of two variables, Counting, Summation of a set of numbers, Factorial computation, Generation of Fibonacci Sequence, Reversing the digits of an Integer, Base Conversion.

Activities:

Solving problems based on number systems and logics, Virtual Demonstration of Computational thinking, Algorithm Development for simple mathematical problems

UNIT III PROGRAMMING LANGUAGE: C

Introduction to C: Problem Solving, Problem Analysis Chart, Developing an Algorithm, Flowchart and Pseudocode, program structure, Compilation & Execution process, Interactive and Script mode, Comments, Indentation, Error messages, Primitive data types, Constants, Variables, Reserved words, Arithmetic, Relational, Logical, Bitwise, Assignment, Conditional operators, Input/Output Functions, Built-in Functions.

Practical: Create Problem Analysis Charts, Flowcharts and Pseudocode for simple C programs

UNIT IV CONTROL STRUCTURES AND FUNCTIONS

if, if-else, nested if, switch-case, while, do-while, for, nested loops, Jump statements. Function Declaration, Definition and Calling, Function Parameters and Return Types, Call by Value and Call by Reference, Recursive Functions, Scope and Lifetime of Variables, Header files and Modular Programming. Practical: Usage of conditional logics in programs. (Minimum three) Usage of functions in programs.
UNIT V STRINGS & POINTERS
One-dimensional and Multi-dimensional Arrays, Array operations and traversals, String Handling: String declaration, input/output, string library functions, Pointer arithmetic, Pointers and Arrays, Pointers to function, Dynamic memory allocation. Practical: Programs using pointers, dynamic memory, pointer arithmetic, string manipulations, array operations. (Minimum three)

TOTAL PERIODS	**60**

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Explain computer fundamentals and use office tools for data processing.
CO2	Apply computational thinking and algorithms to solve problems.
CO3	Understand program development concepts and design tools.
CO4	Develop programs using Scratch with logic and control structures.
CO5	Build simple applications using problem-solving and modular design.

REFERENCES

Thareja, R. (2020). Fundamentals of computers. Oxford University Press. Rajaraman, V., & Adabala, N. (2014). Fundamentals of computers. PHI Learning. Brookshear, J. G., & Brylow, D. (2015). Computer science: An overview. Pearson. Thareja, R. (2021). Programming in C. Oxford University Press.

Balagurusamy, E. (2019). Programming in ANSI C. McGraw Hill Education. Kanetkar, Y. (2020). Let us C. BPB Publications.

Kalicharan, N. (2022). Learn to program with C: An introduction to programming using the C language. Apress.

E-RESOURCES

Brennan and Resnick's CT Framework 2012:

CS50X 2025 Scratch YouTube lectures by Prof. David J Malan, Harvard University:
https://www.youtube.com/watch?v=2WtPyqwTLKM
https://teachinglondoncomputing.org/resources/developing-computational-thinking/ Learn-C.org - https://www.learn-c.org/

GeeksforGeeks - C Programming - https://www.geeksforgeeks.org/cprogramming-language/ GNU C Library Documentation - https://www.gnu.org/software/libc/manual/

"Introduction to C Programming", Swayam MOOC Course, https://onlinecourses.swayam2.ac.in/imb25_mg71/

CO/PO/PSO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	-	-	2	-	-	-	1	-	1	2	-	-
CO2	3	3	2	1	2	-	-	1	1	-	1	3	1	-
CO3	3	2	2	1	2	-	-	1	1	-	1	3	2	-
CO4	3	2	2	2	3	-	-	1	2	-	1	3	2	1
CO5	3	2	3	2	3	1	1	2	3	2	3	3	3	2
AV G	3	2.2	2.25	1.5	2.4	1	1	1.25	1.6	2	1.4	2.8	2	1.5

26ME1I02	ENGINEERING GRAPHICS AND DESIGN	L	T	P	C
		1	0	4	3

Course Objectives

1	To understand and apply drawing instruments, BIS standards, lettering, dimensioning practices and construct conic sections.
2	To analyze and construct orthographic projections of points, straight lines, and planes using first-angle projection method.
3	To illustrate and develop projections of simple solids such as prisms, pyramids, cylinders, and cones.
4	To understand and develop lateral surfaces of simple and sectioned solids.
5	To create and visualize isometric and perspective projections and apply CAD tools for 2D and 3D modeling.

UNIT I FUNDAMENTALS

Drawing instruments, Drawing standards (BIS), Lettering in engineering, Sheet layout, elements of dimensioning, Systems of dimensioning. Free hand sketching of 2D & 3D objects.

Activities: Virtual Demonstration of Conics and Cycloids.

UNIT II ORTHOGRAPHIC PROJECTION

First angle projection, straight lines and planes

UNIT III PROJECTION OF SOLIDS

Simple Solids (prisms, pyramids, cylinder, cone).

Activities: Development of models of various solids and virtual demonstration of sectioning, CAD modelling of 2D objects.

UNIT IV DEVELOPMENT OF SURFACES

Development of lateral surfaces of simple and sectioned solids — Prisms, pyramids cylinders and cones.

Activities: Practicing three dimensional modeling of simple objects by CAD Software

UNIT V PERSPECTIVE PROJECTION

Perspective projection of simple solids-Prisms, pyramids and cylinders by visual ray method

Activities: Virtual demonstration of perspective views.

Project: Development of 2D objects and 3D objects using CAD tools.

TOTAL PERIODS	**45**

Course Outcomes

At the end of the course, the student will be able to

CO1	Students will be able to apply drawing standards and construct conic sections like ellipse, parabola, and hyperbola.
CO2	Students will be able to draw orthographic projections of points, lines, and planes using first-angle projection.
CO3	Students will be able to draw projections of simple solids in different orientations.
CO4	Students will be able to develop lateral surfaces of simple and sectioned solids.
CO5	Students will be able to construct isometric and perspective views and create basic 2D

	and 3D CAD models.

TEXT BOOKS

1. Natarajan, K. V. (2025). A Text Book of Engineering Graphics. Dhanalakshmi Publisher.
2. Venugopal, K., & Prabhu Raja, V. (2022). Engineering Drawing + AutoCAD. New Age International Publishers

REFERENCES

1. Agarwal, B., & Agarwal, C. M. (2019). Engineering Drawing. McGraw Hill Education.
2. Gopalakrishna, K. R. (2017). Engineering Drawing (Vol. I & II combined). Subhas Publications, Bangalore.
3. Luzzader, W. J., & Duff, J. M. (2005). Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production. Prentice Hall of India Pvt. Ltd., New Delhi.
4. Parthasarathy, N. S., & Vela Murali. (2015). Engineering Graphics. Oxford University Press, New Delhi.
5. Shah, M. B., & Rana, B. C. (2009). Engineering Drawing. Pearson Education India.

CO/PO/PSO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	1	–	2	–	–	–	–	2	–	2	3	2
CO2	3	2	2	–	2	–	–	–	–	1	–	2	3	2
CO3	3	3	2	–	2	–	–	–	–	1	–	2	3	2
CO4	3	3	3	–	2	–	–	–	–	1	–	2	3	2
CO5	2	2	3	1	3	–	–	–	1	2	–	2	3	2
AVG	2.8	2.4	2.2	1.0	2.2	–	–	–	1.0	1.4	–	2.0	3.0	2.0

26ME1L01	MAKERSPACE	L	T	P	C
		0	0	4	2

Course Objectives	
1	To understand and perform disassembly and assembly of mechanical systems and household appliances using appropriate tools and techniques.
2	To apply welding procedures and demonstrate welding operations using different welding processes with safety measures.
3	To understand and execute basic electrical wiring and connections for domestic and industrial applications
4	To analyze and implement basic electronic circuits, soldering practices, and integration of components using microcontrollers.
5	To explore and apply modern manufacturing techniques such as CAD modeling, 3D printing, and laser cutting.

(A) DIS-ASSEMBLY & ASSEMBLY PRACTICES	**12**
i. Tools and its handling techniques. ii. Dis-assembly and assembly of home appliances – Grinder Mixer Grinder, Ceiling Fan, Table Fan & Washing Machine. iii. Dis-assembly and assembly of Air-Conditioners & Refrigerators. iv. Dis-assembly and assembly of a Bicycle.	
(B) WELDING PRACTICES	**12**
i. Welding Procedure, Selection & Safety Measures. ii. Power source of Arc Welding – Gas Metal Arc Welding & Gas Tungsten Arc Welding processes. iii. Hands-on session of preparing base material & Joint groove for welding. iv. Hands-on session of MAW, GMAW, GTAW, on Carbon Steel & Stainless Stell plates / pipes, for fabrication of a simple part.	
(C) ELECTRICAL WIRING PRACTICES	**12**
i. Electrical Installation tools, equipment & safety measures. ii. Hands-on session of basic electrical connections for Fuses, Miniature Circuit Breakers and Distribution Box. iii. Hands-on session of electrical connections for Lightings, Fans, Calling Bells. iv. Hands-on session of electrical connections for Motors & Uninterruptible Power Supply.	
(D) ELECTRONICS COMPONENTS / EQUIPMENT	**12**
Practices i. Electronic components, equipment & safety measures. ii. Dis-assembly and assembly of Computers. iii. Hands-on session of Soldering Practices in a Printed Circuit Board. iv. Hands-on session of Bridge Rectifier, Op-Amp and Transimpedance amplifier. v. Hands-on session of integration of sensors and actuators with a Microcontroller. vi. Demonstration of Programmable Logic Control Circuit.	
(E) CONTEMPORARY SYSTEMS	**12**
i. Demonstration of Solid Modelling of components. ii. Demonstration of Assembly Modelling of components. iii. Fabrication of simple components / parts using 3D Printers. iv. Demonstration of cutting of wood / metal in different complex shapes using Laser Cutting Machine.	
TOTAL PERIODS	**60**

Course Outcomes	
At the end of the course, the student will be able to	
CO1	Students will be able to disassemble and assemble mechanical systems and appliances using proper tools.
CO2	Students will be able to perform welding operations using MAW, GMAW, and GTAW processes safely.
CO3	Students will be able to execute electrical wiring for basic domestic and industrial circuits.
CO4	Students will be able to build and test basic electronic circuits and integrate sensors with microcontrollers.
CO5	Students will be able to create models and fabricate components using CAD tools, 3D printing, and laser cutting.
REFERENCES	
1. Stephen Christena, Learn to Weld: Beginning MIG Welding and Metal Fabrication Basics, Crestline Books, 2014. 2. H. Lipson, Fabricated - The New World of 3D Printing, Wiley, 1st edition, 2013. 3. Code of Practice for Electrical Wiring Installations (IS 732:2019)	

COURSE OUTCOMES	
At the end of the course, the student will be able to	
CO1	Students will be able to disassemble and assemble mechanical systems and appliances using proper tools.
CO2	Students will be able to perform welding operations using MAW, GMAW, and GTAW processes safely.
CO3	Students will be able to execute electrical wiring for basic domestic and industrial circuits.
CO4	Students will be able to build and test basic electronic circuits and integrate sensors with microcontrollers.
CO5	Students will be able to create models and fabricate components using CAD tools, 3D printing, and laser cutting.
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3	Code of Practice for Electrical Wiring Installations (IS 732:2019)

CO/PO/PSO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PSO 1	PSO 2	PSO 3
CO1	3	2	1	–	2	–	–	–	1	1	–	3	2	2
CO2	3	2	2	–	2	–	–	–	1	1	–	3	2	2
CO3	3	2	2	–	2	–	–	–	1	1	–	2	3	2
CO4	3	3	2	1	3	–	–	–	1	1	–	2	3	2
CO5	2	2	3	1	3	–	–	–	2	2	–	2	3	3
AV G	2.8	2.2	2.0	1.0	2.4	–	–	–	1.2	1.2	–	2.4	2.6	2.2

26LS1S01	LIFE SKILLS FOR ENGINEERS – I	L	T	P	C
		1	0	2	1

Course Objectives

1	To equip engineering students with essential life skills encompassing personal and emotional development, effective management of time and stress, financial literacy, digital safety, and civic responsibility.
2	To enhance self-awareness, interpersonal skills, and resilience to prepare students for the professional and personal challenges of engineering careers and life beyond academics.

PERSONAL AND EMOTIONAL DEVELOPMENT

Self-Awareness & Personality, Emotional Intelligence & Empathy, Positive thinking, Right attitude, Stress & Anger Management, Goal-Setting & Time Management, Growth Mindset & Resilience.

Activities: Personality tests (MBTI, DISC), reflection journals, Empathy circle, role-playing difficult conversations, Guided mindfulness sessions, stress relief toolkit creation, Vision board creation, weekly time audit and planner, Group challenge scenarios, resilience journal.

MANAGEMENT SKILLS

Financial Literacy: Budgeting & Saving, Nutrition, Health, and Hygiene, Digital Literacy & Online Safety, Civic Responsibility & Ethics

Activities: Create a monthly budget, financial simulation game, Meal planning workshop, physical wellness challenge, Social media audit, privacy and safety scenarios, Community service, values debate.

TOTAL PERIODS	**15**

REFERENCES:

1. Khera, S. (2003). You can win. Macmillan.
2. Levesque, H. (n.d.). Life skills 101: A practical guide to leaving home and living on your own. (Publication year not specified)
3. Mitra, B. K. (2017). Personality development & soft skills (3rd impression). Oxford University Press.
4. ICT Academy of Kerala. (2016). Life skills for engineers. McGraw Hill Education (India) Private Ltd.

26LS1S02	PHYSICAL EDUCATION - I	L	T	P	C
		0	0	4	1

Course Objectives	
1	To impart the fundamentals of physical education for development of students' physical, mental, and social well-being.
2	To instill a lifelong appreciation for physical activity towards the development of positive attitude and fostering values of team work and sportsmanship.

UNIT I INTRODUCTION TO PHYSICAL EDUCATION
Exercise for Good Posture – Conditioning and Calisthenics for Before start, Jogging, Bending, Twisting, Standing, Sitting and Relaxation, Training on First Aid Practices.
UNIT II PARTICIPATION OF ATHLETIC EVENTS
Rules and regulations of important athletic events, Sprint, Jumps, Throws and Hurdles.
UNIT III SKILL DEVELOPMENT IN ANY ONE OF THE FOLLOWING OUTDOOR GAMES
Basket Ball, Volley Ball, Ball Badminton, Football, Hockey, Kho-Kho, Kabaddi, Cricket, Hand ball and Tennis.
UNIT IV SKILL DEVELOPMENT IN ANY ONE OF THE FOLLOWING INDOOR GAMES
Shuttle Badminton, Chess and Table Tennis.

TOTAL PERIODS	**15**

REFERENCES	
1	Singh, A. (2008). Essentials of physical education. Kalyani Publishers.
2	Kamlesh, M. L. (2006). Psychology in physical education and sport (3rd ed.). Metropolitan Book Co.
3	Mangal, S. K. (2009). Psychology of sports performance. Sports Publication.
E-RESOURCES	
1	https://www.who.int/health-topics/physical-activity

CO/PO/PSO Mapping

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PSO 1	PSO 2	PSO 3
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	1	-	-
CO3	-	-	-	-	-	-	-	3	-	-	-	-	-	2
CO4	-	-	-	-	-	-	-	-	-	-	2	-	-	2
AVG	3							3			2	1		2