Higher National Certificate/Diploma Assessment

Qualification	**Pearson BTEC Higher Nationals for England (2024)**
Unit number and title	**4002. Engineering Mathematics**
Assignment title	Analytical & Computational Methods
Assessor	Engineering Team

Academic year	1	**Unit Code**	J/651/0708	**Assignment**	2 of 3

Internal Verifier	Dr. Mike Shaw	**Verification Date**	1st September 2025
Issue Date	1st September 2025	**Final Submission Date**	No later than 31st August 2026

Policy on the Use of Artificial Intelligence (AI)

- Students are required to acknowledge the use of AI in the preparation of any assignment.
- AI tools **may be** permissible for use as learning aids, subject to the AI Assessment Scale designation given below.
- AI cannot be used to generate the final, submitted work in its entirety.
- AI cannot be used to substitute for a student's own critical thinking, analysis, and original expression.
- Assignments must reflect the student's original thought and understanding.
- Assignments are checked automatically on submission for AI content, through Turnitin.
- Assignment grades are only confirmed following viva voce examination at the end of each unit.

Artificial Intelligence Assessment Scale (AIAS)

Full details of the Artificial Intelligence Assessment Scale (AIAS) are available at this link.

The AI Assessment Scale (AIAS)

Level	Description	Guidelines
1 **NO AI**	The assessment is completed entirely without AI assistance in a controlled environment, ensuring that students rely solely on their existing knowledge, understanding, and skills.	**You must not use AI at any point during the assessment. You must demonstrate your core skills and knowledge.**
2 **AI PLANNING**	AI may be used for pre-task activities such as brainstorming, outlining and initial research. This level focuses on the effective use of AI for planning, synthesis, and ideation, but assessments should emphasise the ability to develop and refine these ideas independently.	**You may use AI for planning, idea development, and research. Your final submission should show how you have developed and refined these ideas.**
3 **AI COLLABORATION**	AI may be used to help complete the task, including idea generation, drafting, feedback, and refinement. Students should critically evaluate and modify the AI suggested outputs, demonstrating their understanding.	**You may use AI to assist with specific tasks such as drafting text, refining and evaluating your work. You must critically evaluate and modify any AI-generated content you use.**
4 **FULL AI**	AI may be used to complete any elements of the task, with students directing AI to achieve the assessment goals. Assessments at this level may also require engagement with AI to achieve goals and solve problems.	**You may use AI extensively throughout your work either as you wish, or as specifically directed in your assessment. Focus on directing AI to achieve your goals while demonstrating your critical thinking.**
5 **AI EXPLORATION**	AI is used creatively to enhance problem-solving, generate novel insights, or develop innovative solutions to solve problems. Students and educators co-design assessments to explore unique AI applications within the field of study.	**You should use AI creatively to solve the task, potentially co-designing new approaches with your instructor.**

This assignment is based on the AIAS level indicated by the colour above.
Follow the instructions for that level.

If the submitted work falls outside the scope of the AIAS designation above, the assignment will be failed.

References

- Prepare your references and correctly cite them within the body of your assignment using zbib.org.
- Use the Harvard referencing standard of any of the listed UK universities.
- In zbib.org, create a 'Link to this Version' and copy it into your References section.
- **Assignments will be rejected if this process is not followed correctly.**

Submission Format

All text elements of your submission should be word processed, mathematical solutions can be handwritten (neatly) and scanned into your document.

Assignment Format

- **Organisation**: Use clear headings, paragraphs, and sub-sections, to ensure clarity and ease of reading. Refer to Task numbers or sections to make it clear which question you are answering. ***Assignment Structure***

Your assignment **MUST** include the following sections:

- **Cover Page**: Your Course, Name, Unit Name and Assignment number/name
- **Contents Page**: List tasks or questions with page numbers.
- **References**: Correctly cite and list all sources used, but do not use Wikipedia. Please see the detailed advice on page 1.

Submission Requirements

By submitting your assignment, you confirm the following:

- **Originality**: The work is your own, with all sources properly cited.
- **Plagiarism**: You acknowledge that plagiarism and collusion are forms of academic misconduct and are strictly prohibited.
- **Plagiarism Detection**: Your assignment will be submitted to TurnItIn, a plagiarism detection service, that compares your work against databases, online sources, and other students' work.
- **False Declaration**: Making a false declaration is academic misconduct.

Vocational Scenario or Context	You work as a Test Engineer for a global manufacturer of electrical and mechanical components and systems. Your Line Manager is responsible for delegating to you and your colleagues the testing of theory, principles, and hypotheses from several worldwide company divisions. She has asked you to undertake a series of such evaluations.

Task 1

(AIAS – LEVEL 2)

Final submission must be written in the student's own words and demonstrate personal understanding.

Note: You need to have your calculator in radians (RAD) mode for this task (since the angles are given in radians - i.e., π is featured).

a) A current waveform in a robotic arm may be described by…

$i_s = 15\cos\left(4\pi ft - \frac{\pi}{3}\right)$ [A]

where frequency, f = 2Hz and t represents time.

Make time (t) the subject of this formula and hence determine a point in time when the current waveform has a magnitude of +8A.

b) The instantaneous value of a power signal may be described by;

$18\angle\frac{5\pi}{6}$ [W]

Find the magnitude of the vertical and horizontal components of this signal. Note that the symbol ∠ indicates 'angle'.

Task 2

(AIAS – LEVEL 2)

Final submission must be written in the student's own words and demonstrate personal understanding.

a) A resistor, R, is connected in series with an inductor, L. An a.c. current, ii, flows through this RL combination, causing a voltage (V_R) of 40V to be developed across the resistor, and a voltage (V_L) of 30V to be developed across the inductor.

Assuming that V_R is in-phase with i, and V_L leads V_R by 90°, draw a vector diagram for this arrangement and then calculate the magnitude of the resultant voltage across the whole RL combination.

b) A current-carrying filament is subjected to a strong magnetic field within an experimental chamber. It is required to find the force on the filament. The current may be modelled in three-dimensional space as:

$$I = 3i + 2j - 5k$$

and the magnetic field as:

$$B = 2i - 4j + 6k$$

Find the Cross Product of these two vectors to ascertain the characteristics of the force on the filament (i.e., find $I \times B$).

Sketch this Cross Product (or use software to do so).

Task 3 **(AIAS – LEVEL 2)** Final submission must be written in the student's own words and demonstrate personal understanding.	PART 1 The two signals below are sensed by a signal processor; $v_1 = 30\sin(5t)$ $v_2 = A\cos(5t)$ The signal processor adds the signals to form a third signal, which must be described as a distinct signal in the following form; $v_O = 40\sin(5t + \alpha)$ Use a compound angle identity to determine the value of A (the amplitude of v_2). *Ensure that you have your calculator in Radians (RAD) mode when determining your answer.* PART 2 The third harmonic of a sound wave is given by; $5\cos(2\theta) - 7\sin(2\theta)$ Express this sound wave in the form; $R\sin(2\theta + \beta)$
Task 4 **(AIAS – LEVEL 2)** Final submission must be written in the student's own words and demonstrate personal understanding.	a) Use Graph software to plot the current signal given in Task 1 (a). Provide a screenshot of your waveform. b) Use Graph software to plot the two voltage signals (v_1 and v_2) given in Task 3 Part 1. Provide a screenshot of your waveforms. c) Use Geogebra to plot the vector given in Task 1 (b). Provide a screenshot of this vector function.

Sources of information to support you with this Assignment	Bird J. (2021) Higher Engineering Mathematics. 9th Ed. Routledge. Bird J. (2019) Science and Mathematics for Engineering. 6th Ed. Routledge. Glyn J. and Dyke P. (2020) Modern Engineering Mathematics. 6th edition. Pearson. Made Easy Editorial Board (2022) Engineering Mathematics for GATE 2023 and ESE 2023 (Prelims) – Theory and Previous Year Solved Papers. India: Made Easy Publications Pvt Ltd. Rattan K.S., Klingbeil N.W., and Baudendistel C.M. (2021) Introductory Mathematics for Engineering Applications. 2nd Ed. Wiley. Ram M. (2021) Recent Advances in Mathematics for Engineering. CRC Press. Teodorescu P., Stanescu N., and Pandrea N. (2013) Numerical Analysis with Applications in Mechanics and Engineering. Wiley-IEEE Press. Ram M. (2020) Mathematics in Engineering Sciences: Novel Theories, Technologies, and Applications. 1st Edition. CRC Press. Sobot, R. (2022) Engineering Mathematics by Example. 1st Ed. Springer. Stroud, K.A. and Booth, D.J. (2020) Engineering Mathematics. 8th Ed. Bloomsbury Publishing Urbano M. (2019) Introductory Electrical Engineering with Math Explained in Accessible Language. Wiley. Vick B. (2020) Applied Engineering Mathematics. CRC Press.

Revant Learning Outcomes and Assessment Criteria

	Pass		Merit		Distinction
L03	**Use analytical and computational methods for solving engineering and manufacturing sector problems by relating sinusoidal wave and vector functions to their respective applications**				
P6	Solve engineering/ manufacturing problems relating to sinusoidal functions.	**M3**	Use compound angle identities to combine individual sine waves into a single wave, and illustrate graphically.	**D2**	Apply engineering mathematical software to confirm the analytical solutions for at least three engineering/ manufacturing problems involving sinusoidal and vector functions.
P7	Use appropriate methodology to determine engineering parameters of data represented in vector form.				