Module 2 Foundations of Computing

Module title	Foundations of Computing
Module NFQ level (only if an NFQ level can be demonstrated)	n/a
Module number/reference	BSCH-FC
Parent programme(s)	Bachelor of Science (Honours) in Computing Science
Stage of parent programme	Stage 1
Semester (semester1/semester2 if applicable)	Semester 1 & 2
Module credit units (FET/HET/ECTS)	ECTS
Module credit number of units	10
List the teaching and learning modes	Direct, Blended
Entry requirements (statement of knowledge, skill and competence)	Learners must have achieved programme entry requirements.
Pre-requisite module titles	None
Co-requisite module titles	None
Is this a capstone module? (Yes or No)	No
Specification of the qualifications (academic, pedagogical and professional/occupational) and experience required of staff (staff includes workplace personnel who are responsible for learners such as apprentices, trainees and learners in clinical placements)	Qualified to as least a Batchelor of Science (Honours) level in Computer Science or equivalent and with a Certificate in Training and Education (30 ECTS at level 9 on the NFQ) or equivalent.with a Certificate in Training and Education (30 ECTS at level 9 on the NFQ) or equivalent.
Maximum number of learners per centre (or instance of the module)	60
Duration of the module	Two Academic Semesters, 24 weeks teaching
Average (over the duration of the module) of the contact hours per week	4
Module-specific physical resources and support required per centre (or instance of the module)	One class room with capacity for 60 learners

Analysis of required learning effort		
	Minimum ratio teacher / learner	**Hours**
Effort while in contact with staff		
Classroom and demonstrations	1:60	96
Monitoring and small-group teaching		
Other (specify)		
Independent Learning		
Directed e-learning		
Independent Learning		148
Other hours (worksheets and assignments)		6
Work-based learning – learning effort		
Total Effort		250

Allocation of marks (within the module)					
	Continuous assessment	**Supervised project**	**Proctored practical examination**	**Proctored written examination**	**Total**
Percentage contribution	60%			40%	100%

Module aims and objectives

The main objective of this course is to introduce learners to the concepts, notations and operations of mathematics that provide a basis for working in the field of computing. The material covered extends the knowledge of learners who have completed courses in mathematics at secondary level.

Minimum intended module learning outcomes

On successful completion of this module, the learner will be able to:

1. Perform numerical calculations involving integers and real numbers that involve indices, logs and modulo arithmetic
2. Solve algebraic equations
3. Work with Boolean algebra and quantified expressions
4. Solve problems in linear programming
5. Work with sequences and series
6. Explain the principle of induction and carry out simple inductive proofs over the natural numbers
7. Use general formulas for the equations of lines, circles, parabolas and ellipses
8. Solve trigonometric problems
9. Perform differentiation and integration

Rationale for inclusion of the module in the programme and its contribution to the overall MIPLOs

Mathematics is a fundamental part of computing science. No matter what area of ICT a practitioner works in a solid understanding of mathematical concepts is essential. Appendix 1 of the programme document maps MIPLOs to the modules through which they are delivered.

Information provided to learners about the module

Learners receive a programme handbook to include module descriptor, module learning outcomes (MIMLO), class plan, assignment briefs, assessment strategy, and reading materials.

Module content, organisation and structure

Discrete Mathematics

Number sets:

- naturals, cardinals, integers, rationals, reals, complex; basic laws of arithmetic: commutativity, associativity, distribution;
- indices;
- logs;
- modulo arithmetic.

Algebra:

- algebraic expressions and simplification rules; solving polynomials – quadratic and cubic ;
- inequalities;
- solving simultaneous equations in two unknowns.

Boolean Algebra:

- constants, expressions, operators (and, or, not, implication, equivalence), evaluating expressions
- truth-tables;
- predicate calculus: predicates, quantifiers – forall, exists, +, *, #(counting), writing assertions over sequences.

Linear Programming:

- linear inequalities;
- graphing regions of the plane;
- simultaneous inequalities;
- maximising and minimizing constraints;
- using linear programming to calculate optimizations for given problems.

Sequences and Series:

- sequences as lists of numbers formed by rules;
- arithmetic sequences;

- geometric sequences;
- arithmetic series;
- geometric series;
- infinite geometric series.

Induction:
- principle of induction;
- inductive proofs.

Continuous Mathematics

Co-ordinate Geometry:
- line, circle, hyperbola, ellipse

Trigonometry:
- angle measurements: radian, degrees; trigonometric ratios, functions & identities; sine and cosine rules;
- compound angles and associated formulae.

Differentiation:
- limits; differentiation from first principle;
- differentiation by rule: product, quotient and chain;
- implicit and parametric differentiation;
- higher derivatives;
- exponential functions;
- logarithm functions;
- max/min problems.

Integration:
- indefinite and definite integral;
- integration by substitution;
- integration of rational and trigonometric functions;
- calculations of areas and volumes by integration.

Module teaching and learning (including formative assessment) strategy

This module is taught as a series of lectures and tutorial sessions. The lectures discuss and explain to learners the concepts related discrete and continuous mathematics as specified in the module content section. The tutorial sessions give learners the opportunity to apply what they have learnt by working through sample questions and problems.

The module assessment consists of six open book in-class tests (60%), three per semester, and a closed book final examination (40%). Each open book in class test have a value of 10%. These exams are held when a distinct identifiable piece of work has been completed on the module. They are being proposed as in-class tests to allow Direct interaction with the lecturer and to protect against plagiarism.

Timetabling, learner effort and credit
The module is timetabled as two 2-hour lectures per week.

Continuous assessment spreads the learner effort to focus on small steps and helps to ensure learner engagement over the course of the module.

There are 96 contact hours made up of 48 lectures delivered over 24 weeks with classes taking place in a classroom. The learner will need 148 hours of independent effort to further develop the skills and knowledge gained through the contact hours. An additional 6 hours are set aside for learners to work on class tests that must be completed for the module.

The team believes that 250 hours of learner effort are required by learners to achieve the MIMLOs and justify the award of 10 ECTS credits at this stage of the programme.

Work-based learning and practice-placement
There is no work based learning or practice placement involved in the module.

E-learning
The college VLE is used to disseminate notes, advice, and online resources to support the learners. The learners are also given access to Lynda.com as a resource for reference.

Module physical resource requirements
Requirements are for a classroom for 60 learners equipped with a projector.

Reading lists and other information resources
Recommended Text
Stroud, K. A. and Booth, D. J. (2013) *Engineering Mathematics*. Basingstoke: Palgrave MacMillan.

Secondary Reading:
Grossman, P. A. (2009) *Discrete Mathematics for Computing*. Basingstoke: Palgrave Macmillan.

Jenkyns, T. and Stephenson, B. (2018) *Fundamentals of Discrete Math for Computer Science: A Problem-Solving Primer*. London: Springer.

Stanat, D. F. and McAllister, D. F. (1986) *Discrete Mathematics in Computer Science.* London: Prentice-Hall International.

Thomas, G. B., Weir, M. D. and Hass, J. R. (2016) *Thomas' Calculus*. Upper Saddle River: Pearson.

Specifications for module staffing requirements

For each instance of the module, one lecturer qualified to at least Bachelor of Science (Honours) in Computer Science or equivalent, and with a Certificate in Training and Education (30 ECTS at level 9 on the NFQ) or equivalent.with a Certificate in Training and Education (30 ECTS at level 9 on the NFQ) or equivalent.. Industry experience would be a benefit but is not a requirement.

Learners also benefit from the support of the programme Director, programme administrator, learner representative and the Student Union and Counselling Service.

Module Assessment Strategy

The assignments constitute the overall grade achieved, and are based on each individual learner's work. The continuous assessments provide for ongoing feedback to the learner and relates to the module curriculum.

All repeat work is capped at 40%.

No.	Description	MIMLOs	Weighting
1	6 class tests which will assess a subset of the content for this module in a similar environment to the final exam. Class test 1 will assess: Number sets, algebra, indices, logs modulo arithmetic Class test 2 will assess: Boolean algebra, linear programming, sequences and series. Class test 3 will assess: Number sets, algebra, indices, logs modulo arithmetic, Boolean algebra, linear programming, sequences and series. Class test 4 will assess: Induction, trigonometry. Class test 5 will assess: Geometry Class test 6 will assess: Differentiation, Integration.	1-9	10% each
2	Written exam that tests the theoretical aspects of the module	1-9	40%

Sample assessment materials

Note: All assignment briefs are subject to change in order to maintain current content.

Class Test 1 (Example)

Date of Issue: Week 8

NUMBERS AND ARITHMETIC (20 MARKS)

1. What is the difference between a rational and an irrational number? Give an example of each.

(5 marks)

2. What is a binary operation? Give an example of one.

(5 marks)

3. Evaluate each of the following.
   a. 8 mod 3

   b. 6 mod 7

(2.5 marks each)

4. Name a non-commutative binary operation. Give an example to justify your answer.

(5 marks)

SETS (20 MARKS)

5. Given the set A= {x:x is an odd number and $5 \leq x$ and $x \leq 12$} in predicate form **write A in enumerated form.**

(5 marks)

6. If A = {letters of MISSISSIPPI} and B = {letters of MISS}
   a. List A, B

   State whether the following are true or false
   b. $A \subset$ B
   c. $B \subset$ A
   d. $A \subseteq$ A

(5 marks)

7. Given the universal set U = {1, 2, 3, 4, 5, 6, 7} and the sets X = {1, 2, 3, 4, 6}, Y = {2, 4, 6, 7}
   a. Draw a Venn diagram to show U, X, Y
   b. Find $X \cap Y$
   c. Find $X \cup Y$
   d. Find $\bar{X}$
   e. What is the cardinality of X \ Y

(10 marks)

Indices and Logs (20 marks)

8. Simplify the following. You must show your workings. You may leave your answer as a fraction.
    a. $8^{2/3}$
    b. $\frac{y^5 \times y \times z}{y^2}$
    c. $2\log_2 8 - \log_2 \frac{1}{2}$
    d. Solve for x: $2^x = \frac{1}{4}$

(5 marks each)

Algebra (40 marks)

9. Remove the brackets and simplify: $3x(x^2 - 2) - x(x + 4)$

(10 marks)

10. Solve the equation: $x^2 - 2x - 8 = 0$

(10 marks)

11. Solve the following simultaneous equations

$$3x - y = 1$$
$$x - 2y = -8$$

(10 marks)

12. Solve the following inequality and describe the set of values that x can take.

$$-3x + 3 \geq -12, x \in N$$

(10 marks)

Class Test 2 (Example)
Date of Issue: Week 13

BOOLEAN ALGEBRA (30 MARKS)

13. Draw the truth table for the NAND operator i.e. $\boldsymbol{x \ NAND \ y}$
(10 marks)

14. Draw the truth table for: $\boldsymbol{x \land (y \lor z)}$
(10 marks)

15. Prove that the following is true using truth tables:
(10 marks)

$$\neg(\boldsymbol{x} \lor \boldsymbol{y}) \equiv \neg\boldsymbol{x} \land \neg\boldsymbol{y}$$

SEQUENCES AND SERIES (30 MARKS)

16. Evaluate the following:

$$\sum_{r=-1}^{3} r^3$$

(10 marks)

17. Given the geometric sequence 6, 12, 24, find u_n, the nth term.

(10 marks)

18. In an arithmetic series, the sixth term u_6 is -5, and the sum of the first four terms, S_4, is 8. Find the first term, a, and the common difference, d.

(10 marks)

LINEAR PROGRAMMING (40 MARKS)

19. Find the maximum and minimum values of the objective function:

$$\boldsymbol{z = 0.5x + 2.5y}$$

subject to the following constraints:

$$\boldsymbol{x \geq 0}$$
$$\boldsymbol{y \geq 0}$$
$$\boldsymbol{x + y \leq 10}$$
$$\boldsymbol{2x + y \leq 12}$$

Class Test 3 (Example)

Date of Issue: Week 18

NUMBERS AND ARITHMETIC (20 MARKS)

1. What are the real numbers? How are they different to the rational numbers?

(5 marks)

2. What is a unary operation? Give an example of one.

(5 marks)

3. Evaluate each of the following.
   a. 15 mod 2

   b. 16 mod 8

(2.5 marks each)

4. What does it mean for an operation to be associative? Give an example.

(5 marks)

SETS (20 MARKS)

5. Given the universal set U = {1, 2, 3, 4, 5, 6, 7, 11} and the sets X = {1, 2, 4}, Y = {5, 7, 11}
    a. Draw a Venn diagram to show U, X, Y
    b. Find $X \cap Y$
    c. Find $X \cup Y$
    d. Find $\bar{Y}$
    e. Find |X|

ALGEBRA/INDICES (20 MARKS)

6. Solve the following inequality and describe the set of values that x can take.

$$-2x - 10 > -24, \quad x \in N$$

(5 marks)

7. Simplify:

$$\frac{x^{\frac{1}{2}} \times x^{\frac{3}{2}}}{x}$$

(5 marks)

8. Solve the following simultaneous equations

$$3y = -7x + 15$$
$$y + 3 = \frac{1}{3}x$$

(10 marks)

BOOLEAN ALGEBRA (20 MARKS)

9. Draw the truth table for the equivalence operator i.e. $\boldsymbol{x} \equiv \boldsymbol{y}$
    (5 marks)

10. Draw the truth table for: $\boldsymbol{x} \vee (\,\overline{\boldsymbol{y}} \wedge \boldsymbol{z}\,)$ (15 marks)

SEQUENCES AND SERIES (20 MARKS)

11. Evaluate the following:

$$\sum_{r=0}^{4}(2r+3)$$

(5 marks)

12. Given the following geometric series find S_∞

$$\frac{1}{3}+\frac{1}{6}+\frac{1}{12}+\frac{1}{24}+\cdots$$

(5 marks)

13. Given the arithmetic series: 1 + 3 + 5 + 7 + …
    a. Write an expression for U_n
    b. Write an expression for S_n
    c. Use the expression for S_n to calculate S_{20}

(10 marks)

Class Test 4 (Example)

Date of Issue: Week 22

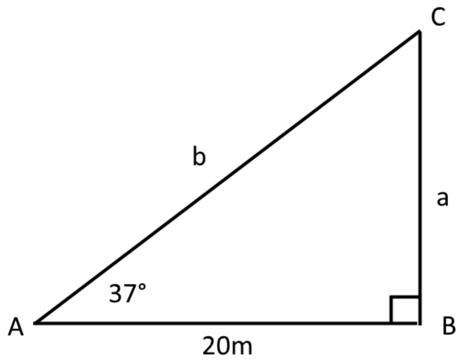
INDUCTION (30 MARKS)

1. Prove by induction that:

$$4+8+12+\cdots+4n=2n(n+1), \forall n \in N$$

TRIGONOMETRY (70 MARKS)

2. The diagram shows a person standing on the ground at point A, flying a kite at point
   C. Find:
   - The height of the kite a
   - The length of string holding the kite b



(20 marks)

3. Find $\sin 240°$ without using a calculator. You must show your work. Leave your answer in surd form.

(20 marks)

4. The radius of a circle is 20 cm. Find the angle (in radians) subtended at the centre by an arc of length 10π. What is this angle in degrees?

(20 marks)

5. Find the area of the following triangle

(10 marks)

Class Test 5 (Example)
Date of Issue: Week 26

THE LINE (40 MARKS)

a(-3, -1) and b(5, 3) are two points in the plane.

1. Find the slope of the line ab

(10 marks)

2. Find the coordinates of c, the midpoint of the line ab

(10 marks)

3. Show that $|ac| = |bc|$

(10 marks)

4. Find the equation of the line ab

(10 marks)

THE CIRCLE (30 MARKS)

5. Find the equation of the circle with centre (0, 0) and radius $\sqrt{7}$

(5 marks)

6. Given the points a(3, 2) and b(7, 12) find the equation of the circle with $[ab]$ as diameter

(10 marks)

7. $L: 3x - y - 30 = 0$ is a line and $C: x^2 + y^2 - 100 = 0$ is a circle. Determine if L is a tangent to C.

(15 marks)

CONIC SECTIONS (30 MARKS)

8. Find the focus of the parabola whose equation is $x = \sqrt{40y}$

(10 marks)

9. Find the area of the ellipse $\frac{x^2}{64} + \frac{y^2}{169} = 1$

(10 marks)

10. What are the asymptotes of the hyperbola $\frac{x^2}{36} - \frac{y^2}{2} = 1$

(10 marks)

Class Test 6 (Example)
Date of Issue: Week 31

DIFFERENTIATION (60 MARKS)

1. Differentiate $-10x^3$ with respect to x.

(5 marks)

2. Find $\frac{d^2z}{dx^2}$ for $z = -x^6 + \frac{3}{2}x^2$

(5 marks)

3. Use the product rule to find $\frac{dy}{dx}$ if $y = (3x+7)(x^2-2)$

(10 marks)

4. Use the quotient rule to find $\frac{dy}{dx}$ if $y = \frac{4x-1}{2x}$

(10 marks)

5. Find $\frac{dy}{dx}$ in terms of t, if: $x = \frac{1}{2} - t$ and $y = t - t^{-2}$

(10 marks)

6. Find the coordinates of the local maximum point, the local minimum point and the point of inflection of the function $y = x^3 - 3x^2 - 9x + 7$

(20 marks)

INTEGRATION (40 MARKS)

7. Find $\int 12x^3 dx$

(5 marks)

8. Evaluate $\int_{-1}^{3}(x^2+6)dx$

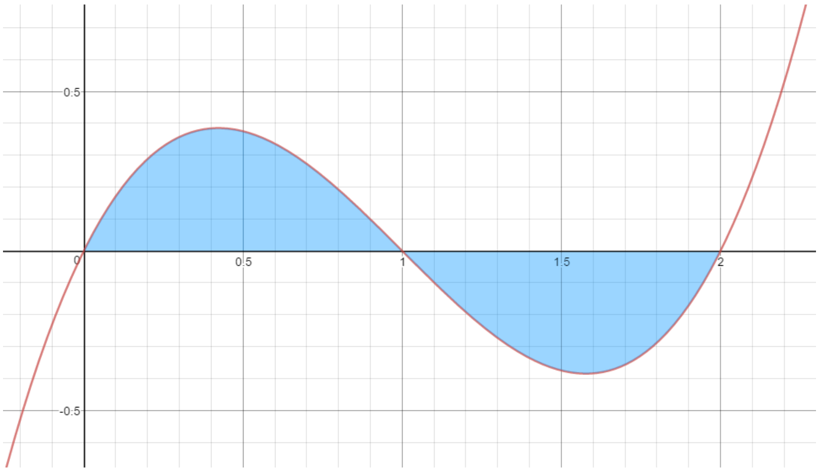
(5 marks)

9. Find the integral $\int 3x^2(x^3-1)^3 dx$ using the substitution $u = x^3 - 1$

(10 marks)

10. The curve $y = x(x-1)(x-2)$ is shown below. Find the area of the shaded region.

(20 marks)


0.5
-0.5
0
0.5
1
1.5
2

GRIFFITH COLLEGE DUBLIN

QUALITY AND QUALIFICATIONS IRELAND

EXAMINATION

FOUNDATIONS OF COMPUTING

Lecturer(s):

External Examiner(s):

Date: **XXXXXXXX** **Time:** **XXXXXXX**

THIS PAPER CONSISTS OF SEVEN QUESTIONS
FIVE QUESTIONS TO BE ATTEMPTED
SECTION A – COMPULSORY
SECTION B – FOUR QUESTIONS TO BE ATTEMPTED
ALL QUESTIONS CARRY EQUAL MARKS
THE USE OF NON PROGRAMMABLE CALCULATORS IS PERMITTED DURING THIS EXAMINATION
LOG TABLES TO BE PROVIDED

SECTION A – COMPULSORY

QUESTION 1 - Select the correct answer and enter into your answer booklet

(i) The equation $x^2 + 4x + 20 = 0$ is:

[a] Linear

[b] Quadratic

[c] Cubic

[d] None of the above

(2 marks)

(ii) If $4y = 4(3 - y)$ then y equals:

[a] 1.5

[b] 3/4

[c] 4

[d] 1.25

(2 marks)

(iii) If you divide an inequality by a negative number, when should you reverse the inequality symbol?

[a] Always

[b] Never

[c] Sometimes

[d] Only if the negative number is a fraction

(2 marks)

(iv) Which set of points is in the solution set for the system of equations:
$2x + y = 1$ and $y = 2x - 5$.

[a] (1, 1)

[b] (-2/3, -1/3)

[c] (0, 0)

[d] None of the above

(2 marks)

(v) Solve for z: $10z - 3 + z = 17 - 9z$

[a] 1

[b] 2

[c] 19

[d] -1

(2 marks)

(vi) Solve: -3x + 7 < -7 - x

[a] x < 7

[b] x > 7

[c] x < 3

[d] x > -3

(2 marks)

(vii) Solve for *w*: $w^2 - 169 = 0$

[a] {-13, 13}

[b] {13}

[c] {-9, 9}

[d] {169}

(2 marks)

(viii) ⅔ is an example of

[a] A natural number

[b] An integer

[c] A rational number

[d] All of the above

(2 marks)

(ix) Solve for x: $log_2 64 = x$

[a] 1.8

[b] 6

[c] 4.15

[d] 2

(2 marks)

(x) Solve for *x*: *(xz)d - p = 0*

[a] $x = \frac{p}{dz}$

[b] $x = pdz$

[c] $x = \frac{d}{pz}$

[d] None of the above

(2 marks)

Total (20 marks)

SECTION B – FOUR QUESTIONS TO BE ATTEMPTED

QUESTION 2

(a) Given the sets A = {2,4,6,8}, B = {1,2,3,4} and C = {10,11,12,13}

Find: (i) A ∩ B

(1 mark)

(ii) B ∩ C

(1 mark)

(iii) |A ∪ B ∪ C|

(1 mark)

(iv) B \ A

(1 mark)

(b) Given the quadratic equation: $4x^2 - 6x + 1 = 0$, solve for x to 2 decimal places.

(4 marks)

(c) P is the line 2x - y = 7. If K is a line perpendicular to P and passes through the point (2,-3), find the equation of the line K.

(6 marks)

(d) Simplify the expression:

$$(x^3+6x^2+11x+6) / (x^2+3x+2)$$

(6 marks)

Total (20 marks)

QUESTION 3

(a) Evaluate the following:

$$\sum_{r=0}^{4}(-1)^{r+1}(3r)$$

(10 marks)

(b) The third term of an arithmetic series is 10 and the eighth term is 25. Find in terms of n:

(i) U_n

(5 marks)

(ii) S_n

(5 marks)

Total (20 marks)

QUESTION 4

(a) Find the centre and radius length of the circle $x^2 + y^2 - 6x - 4y + 12 = 0$.

(9 marks)

(b) The radius of a circle is 10 cm. Find the angle subtended at the centre by an arc of length 20π cm.

(5 marks)

(c) X is an acute angle such that sinX = ½ . Find the value of cosX in surd form.

(6 marks)

Total (20 marks)

QUESTION 5

Prove by induction that $2^n \geq n^2, \forall\, n \in N, n \geq 4$

(20 marks)

QUESTION 6

(a) Differentiate with respect to x:

$$3x^3 + 6x^2 - 2\sqrt{x}$$

(7 marks)

(b) Evaluate the following limit:

$$\lim_{x \to 1} \frac{x^2 - 1}{x - 1}$$

(7 marks)

(c) Evaluate the integral

$$\int_1^3 (4x^2)dx$$

(6 marks)

Total (20 marks)

QUESTION 7

A new ship is being designed. It can have two types of cabin accommodation for passengers — type A cabins and type B cabins.

Each type A cabin accommodates 6 passengers and each type B cabin accommodates 3 passengers. The maximum number of passengers that the ship can accommodate is 330.

Each type A cabin occupies 50 square metres of floor space. Each type B cabin occupies 10 square metres of floor space. The total amount of floor space occupied by cabins cannot exceed 2300 square metres .

(a) Taking x to represent the number of type A cabins and y to represent the number of type B cabins, write down two inequalities in x and y and illustrate these on graph paper.

(10 marks)

(b) The income on each voyage from renting the cabins to passengers is €600 for each type A cabin and €180 for each type B cabin. How many of each type of cabin should the ship have so as to maximise income, assuming that all cabins are rented?

(10 marks)

Total (20 marks)