C.I. APPLIED PHYSICS AND BIOSTATISTICS (6 CFU)

Module PHYSICS APPLIED TO BIOTECHNOLOGIES + Module PRINCIPLES OF MATHEMATICS AND BIOSTATISTICS

Academic Year 2025/2026 · Prof. Notarstefano

Name & Surname: _____	Date: _____	Student ID: _____

Section	Type	Questions	Pts each	Max pts
Mathematics	True/False	6	0.75	4.5
Physics Theory	True/False	10	0.75	7.5
Mathematics	Multiple Choice	4	1.0	4.0
Physics Theory	Multiple Choice	8	1.0	8.0
Physics Exercises	Multiple Choice	3	3.0	9.0
TOTAL		**31**		**33.0**

- **True/False** (0.75 pts each): Circle T or F. Wrong answers are not penalised.
- **Multiple Choice** (1 pt each): Choose one answer. Wrong answers are not penalised.
- **Physics Exercises MC** (3 pts each): Choose the correct numerical result.
- Write clearly. Use a separate sheet for calculations if needed.

SECTION A — TRUE / FALSE

Indicate whether each statement is True or False · 0.75 points each

Questions	Points each	Section total
16	0.75	12.0

A1 · Mathematics (6 questions)

Q1.

Every elementary function (power, exponential, logarithm, sine, cosine) is continuous everywhere on $\mathbb{R}$.

○ True ○ False

Q2.

The derivative of a constant function f(x) = k is k.

○ True ○ False

Q3.

If f''(x) ≤ 0 on [a, b], then f is concave (concave down) on [a, b].

○ True ○ False

Q4.

Every non-zero rational number has a multiplicative inverse in $\mathbb{Q}$.

○ True ○ False

Q5.

Trigonometric functions are not injective over all $\mathbb{R}$ because they are periodic.

○ True ○ False

Q6.

$\log_a x$ is the inverse function of a^x.

○ True ○ False

A2 · Physics Theory (10 questions)

Q7.

Bernoulli's Equation can be applied to any real viscous fluid under all flow conditions.

○ True ○ False

Q8.

Gauss's Law relates the total electric flux through a closed surface to the total charge enclosed.

○ True ○ False

Q9.

At the point of equilibrium on an inclined plane, the coefficient of static friction equals $\tan\alpha$, where α is the angle of inclination.

○ True ○ False

Q10.

The magnitude of the normal force on a block resting on a horizontal surface always equals the weight of the block, regardless of any additional vertical forces applied.

○ True ○ False

Q11.

According to Archimedes' Principle, the buoyant force on a submerged object depends on the object's own weight.

○ True ○ False

Q12.

In an ideal fluid flowing through a narrowing pipe, the fluid velocity decreases at the constriction.

○ True ○ False

Q13.

The instantaneous velocity vector is always tangent to the trajectory of the object at that point.

○ True ○ False

Q14.

The cross product of two vectors is commutative, meaning $\mathbf{a} \times \mathbf{b} = \mathbf{b} \times \mathbf{a}$.

○ True ○ False

Q15.

According to Newton's Third Law, if object A exerts a force on object B, then B exerts a force on A that is equal in magnitude and direction but opposite in sense.

○ True ○ False

Q16.

If a force acts on an object but the object does not move, the work done by that force is zero.

○ True ○ False

SECTION B — MULTIPLE CHOICE

Select the single correct answer · 1 point each

Questions	Points each	Section total
12	1.0	12.0

B1 · Mathematics (4 questions)

Q1.

The discriminant of $ax^2 + bx + c = 0$ is:

○ A) $\Delta = b^2 + 4ac$
○ B) $\Delta = b^2 - 4ac$
○ C) $\Delta = (b - 2a)^2$
○ D) $\Delta = a^2 - 4bc$

Q2.

The mean of the scores obtained in the first three mathematics written tests by a student is 5.5. In the fourth test they score 6.5. What is the mean after the fourth test?

○ A) 5.75
○ B) 5.5
○ C) 6
○ D) There is not enough data to calculate it.

Q3.

If $f''(x) \geq 0$ for all $x \in [a, b]$, then f is:

○ A) Concave (concave down) on [a, b]
○ B) Convex (concave up) on [a, b]
○ C) Constant on [a, b]
○ D) Monotone decreasing on [a, b]

Q4.

In the context of comparing two means with a Student's t-test, the null hypothesis states that:

○ A) The samples are dependent
○ B) The populations are non-normal
○ C) The observed difference between sample means is due to chance (i.e. the true population means are equal)
○ D) The two means are necessarily different

B2 · Physics Theory (8 questions)

Q5.

In the Continuity Equation $A_1 v_1 = A_2 v_2$, if the cross-sectional area at point 2 is one third of the area at point 1, the velocity at point 2 is:

- ○ A) One third of v_1
- ○ B) The same as v_1
- ○ C) Three times v_1
- ○ D) Nine times v_1

Q6.

A thermodynamic system is defined as:

- ○ A) Only a single particle considered in isolation
- ○ B) A finite portion of matter separated from its surroundings by a boundary
- ○ C) The entire universe including all its matter and energy
- ○ D) Only the gaseous phase of a substance

Q7.

Aerodynamic lift on a wing is generated because:

- ○ A) The wing pushes air downward with equal force
- ○ B) Air flows faster over the upper surface (lower pressure) than under the lower surface (higher pressure), creating a net upward force
- ○ C) The wing is heavier than air and sinks into a high-pressure zone
- ○ D) Pressure is equal on both surfaces of the wing

Q8.

For an ideal gas, the specific heat capacity at constant pressure c_p compared to the specific heat at constant volume c_v satisfies:

- ○ A) $c_p = c_v$
- ○ B) $c_p < c_v$
- ○ C) $c_p > c_v$
- ○ D) $c_p = 0$ and $c_v > 0$

Q9.

For a projectile launched with initial speed v_i at elevation angle θ, the initial velocity components are:

- ○ A) $v_{ix} = v_i \sin\theta$ and $v_{iy} = v_i \cos\theta$
- ○ B) $v_{ix} = v_i \cos\theta$ and $v_{iy} = v_i \sin\theta$
- ○ C) $v_{ix} = v_i \tan\theta$ and $v_{iy} = v_i$
- ○ D) $v_{ix} = v_i$ and $v_{iy} = v_i \tan\theta$

Q10.

On a position–time graph, the instantaneous velocity at a point equals:

- ○ A) The area under the curve at that point
- ○ B) The slope of the chord between two points
- ○ C) The slope of the tangent line at that point
- ○ D) The y-intercept of the graph

Q11.

According to Faraday's Law:

- ○ A) A steady magnetic field generates an electric field
- ○ B) A time-varying magnetic field generates an electric field
- ○ C) A time-varying electric field generates a magnetic field
- ○ D) Electric charges generate magnetic fields

Q12.

Which of the following is the correct expression for linear thermal expansion of a solid rod of initial length L_0 subjected to a temperature change ΔT?

- ○ A) $\Delta L = L_0 \cdot \Delta T$
- ○ B) $\Delta L = \alpha \cdot L_0 \cdot \Delta T$
- ○ C) $\Delta L = \alpha \cdot L_0^2 \cdot \Delta T$
- ○ D) $\Delta L = \alpha \cdot \Delta T / L_0$

SECTION C — PHYSICS EXERCISES

Select the correct numerical result · 3 points each

Questions	Points each	Section total
3	3.0	9.0

Q1.

A cork body floats on water with **4/5 of its volume above the water surface**. Determine the density of the cork. (ρ_{water} = 1000 kg/m³)

- ○ A) 200 kg/m³
- ○ B) 800 kg/m³
- ○ C) 1000 kg/m³
- ○ D) 250 kg/m³

Q2.

A ski slope has a vertical drop of **78 m**. Neglecting friction and air resistance, what will be the skier's speed at the end of the slope? (g = 9.8 m/s²)

- ○ A) 39 m/s
- ○ B) 28 m/s
- ○ C) 62 m/s
- ○ D) 9.8 m/s

Q3.

A boy throws a ball straight up with **v_0 = 15 m/s** (g = 9.8 m/s²). Which pair — **maximum height h** and **total flight time t** — is entirely correct?

- ○ A) h = 22.96 m | t = 3.06 s
- ○ B) h = 11.48 m | t = 1.53 s
- ○ C) h = 11.48 m | t = 3.06 s
- ○ D) h = 22.96 m | t = 4.69 s