

Mockbank

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Introduction to Analysis

Midterm Mock 1 — Preview

Exam-style practice with detailed grading schemes.

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- 3 complete mock midterms
- Full worked solutions and grading schemes
- Exam layout with answer boxes, 14 points per mock
- English and Dutch versions

In this preview

- Page 2 — a complete sample question from Mock 1
- Pages 3–4 — the complete grading scheme for that question
- Page 5 — what the rest of the mock contains

Pricing

1 mock + grading scheme €5

All 3 mocks + grading schemes €12.50

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Question 1 · BMT and sets · 2 points

a. [1 point]

Use a geometric series to write the number $0.4151515 \dots$ (the decimals 15 repeat infinitely after the first decimal 4) as a fraction that cannot be simplified further.

Answer 1a**b. [1 point]**

Let $A = \{x \in \mathbb{N} \mid x^2 < 5\}$ and $B = (-1, 1]$. Write the Cartesian product $A \times B$ in set-builder notation and sketch it in the (two-dimensional Cartesian) plane. Indicate clearly which boundary points belong to $A \times B$ and which do not.

Answer 1b

Maximum 14 points (2+4+4+4). Tick the criteria that apply to each part. An answer that reaches the same result by another valid route earns full marks; see “Also accepted” under each part. The criteria are meant to be route-neutral: judge whether the step was taken, not whether it was written exactly as in the model answer. The deductions under “Notation and motivation” mirror how proofs are graded in this course; apply them at most once per part.

Question 1 · BMT and sets · 2 points

Question 1a [1 point]

Use a geometric series to write the number $0.4151515\dots$ (the decimals 15 repeat infinitely after the first decimal 4) as a fraction that cannot be simplified further.

Model answer

$$0.4151515\dots = \frac{4}{10} + \frac{15}{1000} + \frac{15}{100\,000} + \dots = \frac{4}{10} + \frac{15}{1000} \sum_{k=0}^{\infty} \left(\frac{1}{100}\right)^k.$$

The series is geometric with ratio $r = \frac{1}{100}$ and $0 < r < 1$, so $\sum_{k=0}^{\infty} r^k = \frac{1}{1-r}$. Hence

$$0.4151515\dots = \frac{4}{10} + \frac{15}{1000} \cdot \frac{1}{1 - \frac{1}{100}} = \frac{4}{10} + \frac{15}{1000} \cdot \frac{100}{99} = \frac{4}{10} + \frac{15}{990} = \frac{4}{10} + \frac{1}{66} = \frac{132}{330} + \frac{5}{330} = \frac{137}{330}.$$

Since 137 is prime and does not divide 330, the fraction cannot be simplified further.

Also accepted (full marks):

- Split as $0.4151515\dots = \frac{1}{10} (4 + 0.151515\dots)$ and treat $0.151515\dots = \frac{15}{100} \sum_{k=0}^{\infty} \left(\frac{1}{100}\right)^k = \frac{15}{99}$.
- Series indexed from $k=1$: $\sum_{k=1}^{\infty} 15 \cdot \left(\frac{1}{100}\right)^k = 15 \cdot \frac{1/100}{1-1/100}$, provided the formula used matches the starting index.
- Any equivalent simplified form, e.g. $\frac{411}{990}$ reduced to $\frac{137}{330}$.

Grading scheme

1 / 1 pt

☒ **Correct answer** 1 pt
 $\frac{137}{330}$, with the geometric series written out and the ratio r identified.

☐ **Series set up correctly, arithmetic slip** 0.5 pts
 Right terms and ratio, wrong final fraction.

☐ **– no geometric series used** –0.5 pts
 For example the “ $100x - x$ ” trick only; the question asks for a geometric series.

☐ **– condition $|r| < 1$ not mentioned** –0.25 pts
 The sum formula is used without checking that it applies.

☐ **– fraction not simplified** –0.25 pts
 For example $\frac{411}{990}$ as the final answer.

Question 1b [1 point]

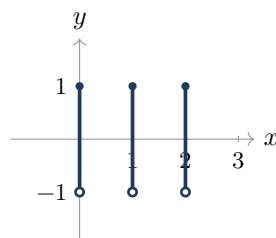
Let $A = \{x \in \mathbb{N} \mid x^2 < 5\}$ and $B = (-1, 1]$. Write the Cartesian product $A \times B$ in set-builder notation and sketch it in the (two-dimensional Cartesian) plane. Indicate clearly which boundary points belong to $A \times B$ and which do not.

Model answer

Since $0^2 = 0$, $1^2 = 1$ and $2^2 = 4$ are smaller than 5 while $3^2 = 9$ is not, and $0 \in \mathbb{N}$ in this course, we have $A = \{0, 1, 2\}$. Therefore

$$A \times B = \{(a, b) \mid a \in \{0, 1, 2\}, b \in (-1, 1]\} = \{(a, b) \mid a \in \{0, 1, 2\}, -1 < b \leq 1\}.$$

The sketch consists of three vertical line segments at $x = 0$, $x = 1$ and $x = 2$, from $y = -1$ (not included, open circle) up to $y = 1$ (included, closed circle).

**Also accepted (full marks):**

- $A \times B$ written as $\{0, 1, 2\} \times (-1, 1]$, or as the union $\{0\} \times (-1, 1] \cup \{1\} \times (-1, 1] \cup \{2\} \times (-1, 1]$, provided A is worked out.
- Excluded end points shown by a dotted end of the segment or by “o”, included end points by a solid end or “•”: any clear convention.

Grading scheme

1 / 1 pt

**Correct answer****1 pt**

A determined, correct set-builder notation and a correct sketch with the end points distinguished.

**Set-builder notation only****0.5 pts**

Notation correct, sketch missing or wrong.

**Sketch only****0.5 pts**

Sketch correct, notation missing or wrong.

 **$0 \notin A$** **−0.25 pts**

$A = \{1, 2\}$ used: the course takes $0 \in \mathbb{N}$.

**end points not distinguished****−0.25 pts**

$y = -1$ and $y = 1$ drawn the same way.

**axes swapped****−0.5 pts**

Horizontal segments at $y = 0, 1, 2$.

This is the complete grading scheme for Question 1 as it appears in the full pack. Every question in every mock is graded to this level of detail, including the notation and motivation deductions this course is known for.

Full Mock 1 · What the rest contains · 14 points in total

The full mock has four questions worth $2 + 4 + 4 + 4 = 14$ points, the structure of a real one-hour midterm. Question 1 is shown in full on page 2; the other three are summarised below without revealing the questions themselves. Every proof question carries the standard deductions for missing motivation, $\Leftrightarrow$ versus $=$, forgotten quantifiers and notation mistakes, so you can grade your own work the way it will be graded.

Question 1 · BMT and sets**2 points**

A repeating decimal via a geometric series, and a Cartesian product in set-builder notation with a sketch. *Shown in full on page 2.*

Question 2 · Set identity**4 points**

Proving a set identity from two given relations between the sets, with a short justification (definition, law or given fact) for every step, graded the way this course grades proofs.

Question 3 · Functions**4 points**

Two parts: a short proof about injectivity from a functional property, and a full treatment of a given function: range, bijectivity proof, inverse with the control step, and a sketch of f and f^{-1} .

Question 4 · Induction**4 points**

An induction proof for a recursively defined sequence, plus the question whether mathematical or complete induction was needed and why.

Full Mock 1 includes

- all mock questions
- full answer spaces
- detailed model answers
- point-by-point grading scheme
- partial-credit guidance
- accepted alternative approaches where applicable

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