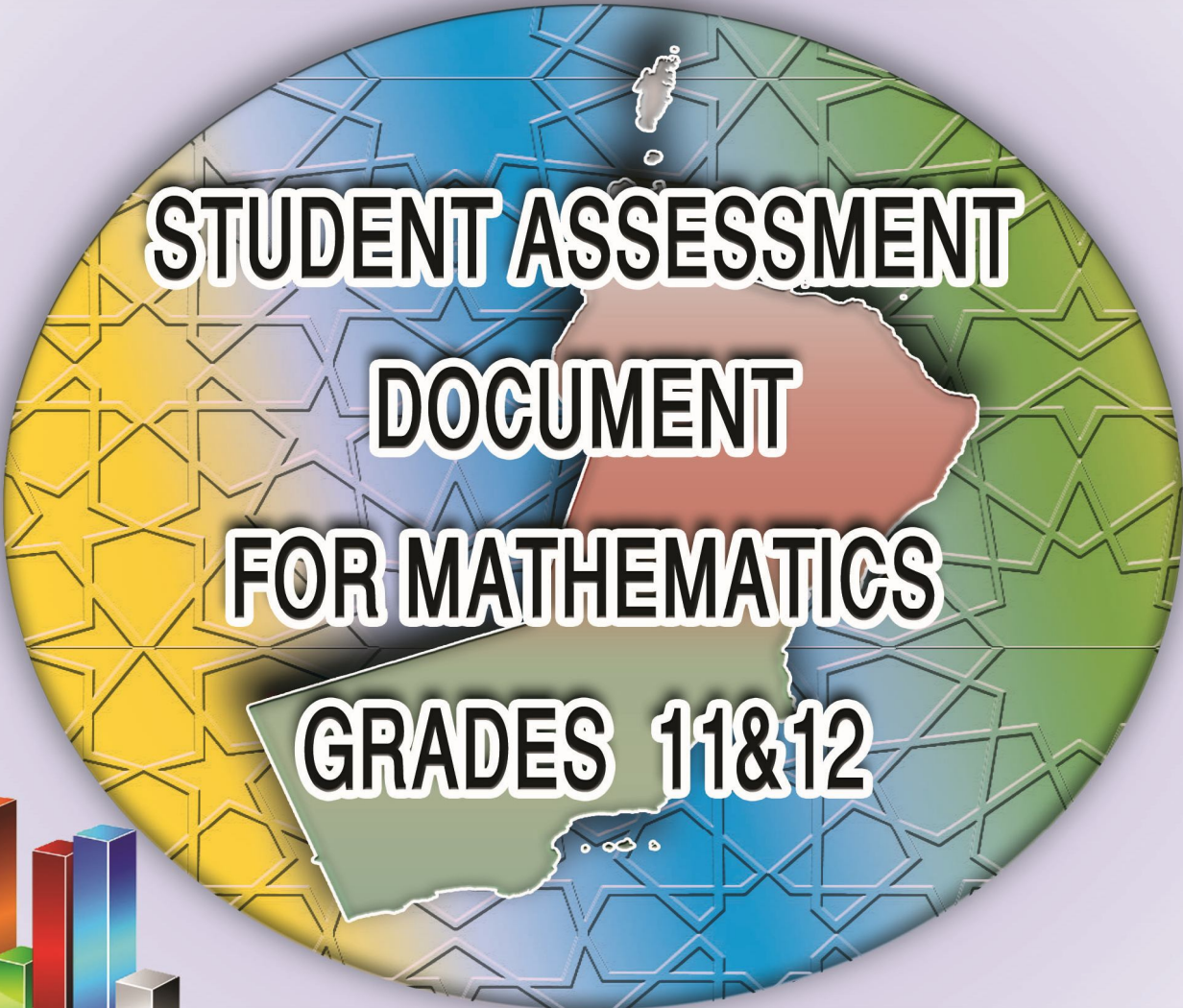




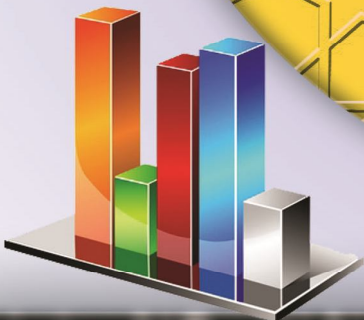
Sultanate of Oman

Ministry of Education

Directorate - General of Educational Evaluation



**STUDENT ASSESSMENT
DOCUMENT
FOR MATHEMATICS
GRADES 11&12**



GENERAL EDUCATION DIPLOMA FOR PRIVATE SCHOOLS (BILINGUAL)

Trial Edition 2011/2012

A. INTRODUCTION:

This document, which is based on the General Assessment Document issued by the Ministry of Education, provides information and guidance for teachers through the assessment of students in learning Mathematics of *Grades 11 and 12*.

B. GENERAL NOTE on CONTINUOUS ASSESSMENT

Continuous Assessment (CA) includes *a range of different assessment techniques* which can be used in the classroom to gather information about students' learning.

Summative assessment is assessment of students' learning, with the aim of providing evidence for reporting to parents and others. *Formative* assessment is assessment for learning, with the aim of helping students to achieve the relevant learning outcomes. Both summative and formative assessments are important and valuable; neither should be neglected.

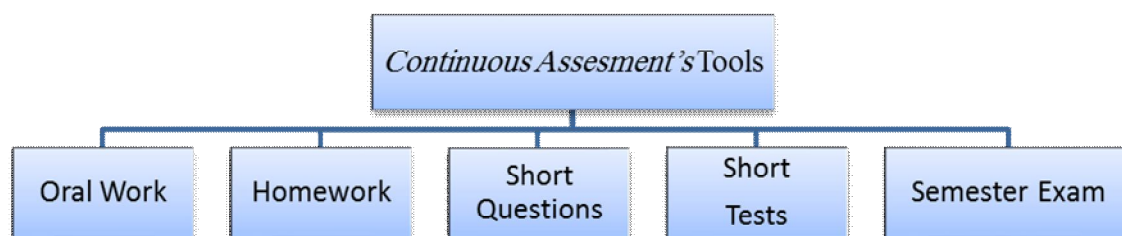
C. THE BENEFITS OF CONTINUOUS ASSESSMENT

The most important ways in which Continuous Assessment (CA) can be beneficial are:

- It is based on a positive view of assessment as a natural part of the teaching-learning process.
- It allows assessment of learning outcomes which are, for practical reasons, difficult to assess by means of formal testing;
- It can provide a fairer, more balanced picture of students' attainment, especially for those who become nervous during formal tests;
- It provides information about students' learning at an early stage, making it possible for action to be taken promptly, while the school year is still in progress;
- It encourages teachers to get to know all of their students well and to closely observe individual students' on-going progress and development;
- It (possibly) motivates students to work hard consistently, if they know that their everyday work in class contributes to their report card assessment.

D. TOOLS & TECHNIQUES FOR CONTINUOUS ASSESSMENT

This Section provides further information and explanation regarding the various tools and techniques, which can be used for assessment purposes, i.e



- i. Oral work: is applied through the teaching and learning process, and through the responses to verbal discussion about an issue or a topic. It is applied usually between two or more persons (between teacher and student or between a group of students or between student and colleague). It includes **dialogues** and **presentations (optional)**.

Taking into account the followings:

- It should measure the learning outcomes of the math syllabus.
- It may include short oral questions that require a specific answer.
- It should be accompanied to the daily teaching practices (during the lessons).
- It could be asking students questions or discussing ideas.
- It should target each time a specific group/level of students.
- Learning cognitive levels should be taken into account (knowledge - application-Reasoning)

Teachers can take advantage of the following standards to give each student an accurate mark according to his/ her participation during the lessons (teachers can set up their own standards).

Domain	Description	Marks
¹ Communication (6 marks)	Using the language of mathematics (e.g., symbols, terminology) to express mathematical ideas precisely.	1
	Presenting his/ her mathematical thinking coherently and clearly to peers, teachers, and others.	2
	Analyzing and evaluating the mathematical thinking and strategies of others	3
Taxonomy (4 marks)	Giving accurate answers to the questions of knowledge	1
	Giving accurate answers to the questions of the application	2
	Giving accurate answers to the questions of the reasoning	1
Total		10

¹ National Council of Teachers of Mathematics-NCTM(2000). Principles and Standards for School Mathematics. Reston, Virginia, USA.

- ii. Homework: tasks assigned to students by their teachers to be done at home or in their spare time at school. The teacher should take into account the Learning cognitive levels (knowledge - application- Reasoning). It must be corrected by the teacher and feedback should be given to students. Homework in grade 12 is given as Formative Assessment.
- iii. Short Questions: One or two short written questions used during the classroom to make sure that students acquire information, knowledge and skills, lasting no more than 5 minutes. Short Questions could be any form (multiple choice or extended response) require few steps in solving.
- iv. Short tests : applied at the end portion of contents (different topics) during the semester. There are two short tests in each semester. The time duration of each test must not exceed 20 minutes. The short test and it's feedback must be given in the same lesson.

General specifications for Short tests

- Consist of two questions: 40% Multiple-choice items, and 60% Extended response items.
 - Question 1: multiple choice, 4 options for each item .
 - For grade 11: (4 items, one mark for each).
 - For grade 12: (3 items, 2 marks for each).
 - Question 2: extended response items (2-3 parts)
 - For grade 11: 6 marks in total.
 - For grade 12: 9 marks in total.
 - The level/type of the given questions should be divided into different learning levels/types (30% Knowledge , 50% applying, 20% Reasoning).
 - The answer key must be prepared for each test.
 - **In grade 11:** each one with 10 marks, then the total will be taken.
 - **In grade 12:** each one with 15 marks, then the average total will be taken.
- v. Semester exam: formal exams administered at the end of the semester. You can find more details in general specifications for semester one and semester two exams.

Important points:

(a) Every test must be divided into two parts:

Part (1) : Multiple choices items worth 40% of the total mark : each item has 2 indivisible marks.

Part (2) : Extended response items worth 60% of the total mark.

(b) The level/type of the given questions should be divided into:

Knowledge	Applications	Reasoning
30%	50%	20%

Based on new Ministry of Education assessment procedures, the following specifications should be applied:

- The marks for each semester will be calculated based on:
 1. Continuous assessment (school-awarded) valued at 40% for grade 11 and 30% for Grade 12.
 2. Semester exam valued at 60% for grade 11 and 70% for Grade 12.
- The marks for the year will be :
 1. For grade 11 the summation of $(40\% + 60\%) = 100\%$.
 2. For grade 12 the summation of $(30\% + 70\%) = 100\%$.
- Student achievement to be reported as a letter-grade, while in grade 12, both letter grades and percentage-marks are used. The following table shows the breakdown of percentage marks and corresponding letter-grades:

Mark Range	Letter-Grade	Descriptor
90% - 100%	A	Excellent
80% - 89%	B	Very good
65% - 79%	C	Good
50% - 64%	D	Satisfactory
49% or less	E	Needs further support

Table (1) : Assessment tools marks distributed among topics on grades 11 & 12

Grade	Semester	Area of Math covered	Topic	Assessment Tools				
				Short Questions	Homework	Short Test		
						1 st	2 nd	
Grade 11	1	Algebra	Quadratic Equations & Functions	0	0	4	-	
			Inequalities	0	0	2	-	
			Equations	2	0	2	-	
			Exponents & Logs	0	3	2	-	
		Geometry	Co-ordinate geometry	0	3	-	4	
		Trigonometry	Solving triangles, Radians and applications	2	0	-	6	
			Trig functions and angles in all	2	3	-	0	
		Total				6	9	10
	2	Algebra	Algebra and functions	2	3	0	-	
			Binomial expansion	0	0	2	-	
		Seq. & Series	Arithmetic series	2	0	3	-	
			Geometric series	0	0	5	-	
		Algebra	Standard functions and curve sketching	0	0	-	4	
		Trigonometry	Identities & Equations	2	3	-	0	
		Algebra	Transformations of graphs	0	3	-	6	
Total				6	9	10	10	

Grade	Semester	Area of Maths covered	Topic	Assessment Tools				
				Short Questions	Home work	Short Test		
						1 st	2 nd	
Grade 12	1	Algebra	Partial fractions	2	-	3	-	
		Calculus	Differentiation	0	-	6	-	
			Differentiation	0	-	6	-	
		Trigonometry	Trig involving all trig ratio's in all quadrants	3	-	-	6	
		Integration	Integration	2	-	-	3	
			Integration	0	-	-	6	
		Probability		3	-	-	0	
	Total				10	-	15	15
	2	Exponents & Logs	The functions (e^x) and $\ln x$	2	-	7	-	
		Calculus	Differentiation	2	-	8	-	
			Further Differentiation	2	-	-	5	
		Integration	Integration	0	-	-	10	
		Statistics	Normal Distribution	4	-	-	0	
	Total				10	-	15	15

Table (2): summary of marks awarded assessment tools in grade 11

Grade 11						
The tool	Continuous Assessment Tools				Total	Final Exam
	Oral Work	Short questions	Homework	Short Test		
Marks	5	6	9	20	40	60
Description	Applied three times and the mark distributed according to standards (page3).	Three Short questions as shown in table(1)	Three Homework as shown in table(1)	Two Short tests in each semester. The mark of each one is according to the relative weight as shown in table (1).		To be done by School

Table (3): summary of marks awarded assessment tools in grade 12

Grade 12					
The tool	Continuous Assessment			Total	Final Exam
	Oral Work	Short questions	Short Test		
	5	10	15	30	70
Description	Applied four times and the mark distributed according to standards (page3) .each time is out of 5 marks and then the average will be taken.	Four Short questions according to the relative weight as shown in table(1).	Two Short tests in each semester. The mark of each one is according to the relative weight as shown in table(1).		To be done by MOE

No repetition or make up tests under any circumstances, but in case of absence with reasonable excuses, a different (new) short test must be given to the absent student(s). A copy of the excuse(s) should be kept with the teacher to be shown when required.

TAXONOMY(COGNITIVE DOMAINS): The following tables represent that in details².

Level		Definition
Knowing	1. Recall	Recall definitions, terminology, number properties, geometric properties, and notation.
	2. Recognize	Recognize mathematical objects, e.g., shapes, numbers, expressions, and quantities. Recognize mathematical entities that are mathematically equivalent.
	3. Compute	Carry out algorithmic procedures. Carry out routine algebraic procedures.
	4. Retrieve	Retrieve information from graphs, tables or other sources, read simple scales.
	5. Measure	Use measuring instruments, choose appropriate units of measurement.
	6. Classify/ Order	Classify/group objects, shapes, numbers and expressions according to common properties; make correct decisions about class membership, and order numbers and objects by attributes.

Level		Definition
Applying	1. Select	Select an efficient/appropriate operation, method or strategy for solving problems where there is a known procedure, algorithm, or method of solution.
	2. Represent	Display mathematical information and data in diagrams, tables, charts, or graphs, and generate equivalent representations for a given mathematical entity or relationship.
	3. Model	Generate an appropriate model, such as an equation, geometric figure, or diagram for solving a routine problem.
	4. Implement	Implement a set of mathematical instructions, e.g. draw shapes and diagrams to given specifications.
	5. Solve Routine Problems	Solve standard problems similar to those encountered in class. The problems can be in familiar contexts or purely mathematical.

²Ruddock, Graham & Preuschoff, Corinna (2009). *TIMSS 2011 Mathematics Framework*, TIMSS 2011 second NRC Meeting, Washington, DC.

Level		Definition
Reasoning	1. Analyze	Determine, describe, or use relationships between variables or objects in mathematical situations, and make valid inferences from given information.
	2. Generalize/ Specialize	Extend the domain to which the result of mathematical thinking and problem solving is applicable by restating results in more general and more widely applicable terms.
	3. Integrate/ Synthesize	Make connections between different elements of knowledge and related representations, and make linkages between related mathematical ideas. Combine mathematical facts, concepts, and procedures to establish results, and combine results to produce a further result.
	4. Justify	Provide a justification by reference to known mathematical results or properties.
	5. Solve Non-Routine Problems	Solve problems set in mathematical or real life contexts where target students are unlikely to have encountered closely similar items, and apply mathematical facts, concepts, and procedures in unfamiliar or complex contexts.

Formal Moderation (Grade 12 only) :

Of the several possible methods which can be used for Formal Moderation, the Ministry has chosen to focus on ‘moderation visits’. These are held towards the end of each semester, shortly before the exams. For an exact, step-by-step description of the procedures and requirements for Formal Moderation Visits, please refer to the documents produced by the Moderation Section of the Department of Attainment Evaluation at the DGEE.

Directorate General of Educational Evaluation staff will moderate continuous assessment marks awarded at schools for grade 12. Teachers should allocate a portfolio for each student. The file has to have evidences (student's work) for the given mark for each assessment tools except for the oral work. As well as the student's work, each folder should contain details of the task assigned, the marking guide, the marks awarded, and any comments from the teacher. Each folder should contain a copy of the task. When visiting the school; the moderator will select and review a sample of folder.

CRITERIA OF CHECKING GRADE 12 CONTINUOUS ASSESSMENT GIVEN MARKS OUT OF 30:

ORAL WORK :

- Comparing student's mark with his/her classmates marks to see the existence of individual differences. In case of no differences, then the teacher has to give reasonable excuses.
- Comparing student's mark in this tool (oral work) with his/her marks in the other tools.
- Discussing with the teacher regarding the used criteria behind his/her assessment. These criteria must be stated in words to be shown when required.

SHORT QUESTIONS :

- The Four Short questions according to the relative weight must be provided. Each one must be done on the specific topic that determined before. That is, the weight and the topic of them must be as stated in table (1). In addition, the cognitive domains percentages must be considered.
- In case the student's question paper is not provided, then the student's mark on the missing evidence will **NOT** be considered (will be deleted).
- Precise clear Answer key must be provided.
- Repeating questions or tests to make student's mark better is not allowed. That is, The test should not be repeated to one student or group of students to make students mark better.

SHORT TESTS :

- No more than two short tests should be given to the students during the semester. That is, taking the best is not there.
- The mark of each short test should be provided according to the relative weight as shown in table (1).
- Precise clear Answer key must be provided.
- In case the tests are not made according to the determined weights, topics, or cognitive domain, or no answer key provided, then a comment will be written against the teacher.
- No repetition or make up tests under any circumstances, but in case of absence with reasonable excuses, a different (new) short test must be given to the absent student(s). A copy of the excuse(s) should be kept with the teacher to be shown when required.
- Repeating questions or tests to make student's mark better is not allowed. That is, The test should not be repeated to one student or group of students to make students mark better.
- In case a test is not provided, then the student's mark on the missing evidence will **NOT** be considered (will be deleted).

END-OF- EXAMINATION FORMAT (60 MARKS) FOR GRADE 11 FOR BOTH SEMESTERS:

The test should be done by the school and specifications should be gotten in a similar way of determining grade12 which is shown below. Supervisors from General Directorate of the private schools should check the test and the specifications behind them.

Question Type & Taxonomy (Cognitive Domains):

	Multiple-Choice (40 %)			Total	Extended Response (60 %)			total
	Knowledge 30 %	Application 50 %	Reasoning 20 %		Knowledge 30 %	Application 50 %	Reasoning 20 %	
Marks	8	12	4	24	11	18	7	36
No. of items	4	6	2	12	3 extended response questions			

General specifications for semester one and semester two exams:

- Time: two and half hours.
- It will be done by the school.

According to the circular issued by the General Directorate of Private Schools on the math syllabus 2011/2012, hence the following two tables show the specifications of the semester one exam and semester two exam.

- Grade 11 : First semester exam:

Area of math. covered	Topic	%	Marks								Total
			Multiple-Choice				Extended Response				
			Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	
ALGEBRA	Quadratic Equations & Functions	11	-	2	-	2	1	2	1	4	6
	Inequalities	4	-	-	-	0	1	1	0	2	2
	Equations	7	-	2	-	2	1	1	0	2	4
	Exponents & Logs	15	2	2	-	4	2	2	1	5	9
GEOMETRY	Co-ordinate geometry	26	2	2	2	6	3	5	2	10	16
TRIGONOMETRY	Solving triangles, Radians and applications	22	2	2	2	6	2	4	2	8	14
	Trig functions and angles in all	15	2	2	-	4	1	3	1	5	9
Total		100	8	12	4	24	11	18	7	36	60

- Grade 11 :Second semester exam:

Area of math covered	Topic	%	Marks								Total
			Multiple-Choice				Extended Response				
			Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	
ALGEBRA	Algebra and functions	10	-	2	-	2	1	2	1	4	6
	Binomial expansion	14		2	2	4	1	2	1	4	8
SEQUENCE & SERIES	Arithmetic series	17	2	2	-	4	2	3	1	6	10
	Geometric series	17	2	2	-	4	2	3	1	6	10
ALGEBRA	Standard functions and curve sketching	14	2	-	-	2	2	3	1	6	8
TRIGONOMETRY	Identities & Equations	28	2	4	2	8	3	5	2	10	18
Total		100	8	12	4	24	11	18	7	36	60

FOR GRADE 12:

END-OF- EXAMINATION FORMAT (70 MARKS) FOR GRADE 12 FOR BOTH SEMESTERS:

Question Type & Taxonomy (Cognitive Domains):

	Multiple-Choice (40 %)			Total	Extended Response (60 %)			total
	Knowledge 30 %	Application 50 %	Reasoning 20 %		Knowledge 30 %	Application 50 %	Reasoning 20 %	
Marks	8	14	6	28	13	21	8	42
No. of items	4	7	3	14	3 extended response questions			

General specifications for semester one and semester two exams:

- Time: 3 hours.
- It will be done centrally by MOE.

The following two tables show the specifications of the semester one exam and semester two exam.

- Grade12: First semester exam:

Area of math covered	Topic	%	Marks								Total
			Multiple-Choice				Extended Response				
			Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	
Algebra	Partial fractions C4:8 (pg 179-187)	11	-	2	-	2	3	3	-	6	8
Calculus	Differentiation C1:9 (pg 148-164)	15	2	2	-	4	2	3	2	7	11
	Differentiation C2:15(pg 230-243)	12	-	2	-	2	-	3	3	6	8
Trigonometry	Trig involving all trig ratio's in all quadrants C3:3 (pg 46-80)	27	2	4	2	8	3	5	3	11	19
Integration	Integration C1:10 (pg 165-173)	12	2	2	-	4	2	2	-	4	8
	Integration C2:19 (pg 325-347)	12	2	-	2	4	2	2	-	4	8
Probability	-	11	-	2	2	4	1	3	-	4	8
Total		100	8	14	6	28	13	21	8	42	70

EXAMINATION FORMAT

SEMESTER ONE

Question One:	Multiple Choice: 14 items at 2 marks Partial Fraction (C4:8): 1 items @ 2 = 2 marks Differentiation (C1:9): 2 items @ 2 = 4 marks Differentiation (C2:15): 1 items @ 2 = 2 marks Trigonometry (C3:03): 4 item @ 2 = 8 marks Integration (C1:10): 2 items @ 2 = 4 marks Integration (C2:19): 2 items @ 2 = 4 marks Probability: 2 items @ 2 = 4 marks	28 marks
Question Two:	Extended Response: (a) Partial Fraction (C4:8)= 6 marks (i) = 3 marks (knowledge) (ii) = 3 marks (application) (b) Differentiation (C1:9) = 3 marks (application) (c) Trigonometry (C3:03) = 5 marks (i) = 3 marks (application) (ii) = 2 marks (application)	14 marks
Question Three:	Extended Response: (a) Differentiation(C1:9)= 4 marks (i) =2 marks (knowledge) (ii) =2 marks (reasoning) (b) Differentiation(C2:15) = 6 marks (i) = 3 marks (application) (ii) = 3 marks (reasoning) (c) Integration (C1:10)= 4 marks (i) = 2 marks (knowledge) (ii) = 2 marks (application)	14 marks
Question Four:	Extended Response: (a) Trigonometry =6marks (i) =3 marks (knowledge) (ii) =3 marks (reasoning) (b) Integration (C2:19) =4 marks (i) = 2 marks (knowledge) (ii) = 2 marks (application) (c) Probability= 4 marks (i) = 1 marks (knowledge) (ii) = 3 marks (application)	14 marks

Total

70 marks

- Grade12: Second semester exam:

Area of maths covered	Topic	%	Marks								Total
			Multiple-Choice				Extended Response				
			Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	Knowledge 30 %	Application 50 %	Reasoning 20 %	Total	
Exponent and logs	The function e^x and $\ln x$ C3:4 (pg 90-96)	17	-	2	2	4	4	4	-	8	12
Calculus	Differentiation C4:10(pg 98-136)	25	2	4	2	8	2.5	5	2	9.5	17.5
	Further Differentiation C2:15(pg 201-213)	17	2	2	-	4	2	4	2	8	12
Integration	Integration C4:12(12.1-12.4) (pg 244-270)	25	2	4	2	8	3	4.5	2	9.5	17.5
Statistics	Normal distribution	16	2	2	-	4	1.5	3.5	2	7	11
Total		100	8	14	6	28	13	21	8	42	70

EXAMINATION FORMAT

Semester Two

Question One: Multiple Choice: 14 items at 2 marks 28 marks

The function e^x and $\ln x$ (C3:4): 2 items @ 2 = 4 marks
Differentiation (C4:10): 4 items @ 2 = 8 marks
Further Differentiation (C2:15): 2 items @ 2 = 4 marks
Integration (C4:12): 4 items @ 2 = 8 marks
Statistics: 2 items @ 2 = 4 marks

Question Two: Extended Response: 14 marks

(a) The function e^x and $\ln x$ (C3:4) = 4 marks (knowledge)

(b) Further Differentiation (C2:15) = 8 marks

(i) = 2 marks (knowledge)

(ii) = 4 marks (application)

(iii) = 2 marks (reasoning)

(c) Integration (C4:12) = 2 marks (reasoning)

Question Three: Extended Response: 14 marks

(a) The function e^x and $\ln x$ (C3:4): 4 marks (application)

(b) Statistics = 7 marks

(i) = 1.5 marks (knowledge)

(ii) = 3.5 marks (application)

(iii) = 2 marks (reasoning)

(c) Integration (C4:12) = 3 marks (knowledge)

Question Four: Extended Response: 14 marks

(a) Differentiation (C4:10): 4.5 marks

(i) = 2.5 marks (knowledge)

(ii) = 2 marks (reasoning)

(a) Differentiation (C4:10): 5 marks (application)

(b) Integration (C4:12): 4.5 marks (application)

Statistics = 3.5 marks (application)

Total

70 marks

MORE EXPLANATION FOR THE THREE COMPONENTS (KNOWING-APPLYING-REASONING): *

Knowing:

Facility in using mathematics, or reasoning about mathematical situations, depends on mathematical knowledge and familiarity with mathematical concepts. The more relevant knowledge a student is able to recall and the wider the range of concepts he or she has understood, the greater the potential for engaging in a wide range of problem-solving situations and for developing mathematical understanding.

Without access to a knowledge base that enables easy recall of the language and basic facts and conventions of number, symbolic representation, and spatial relations, students would find purposeful mathematical thinking impossible. Facts encompass the factual knowledge that provides the basic language of mathematics, and the essential mathematical facts and properties that form the foundation for mathematical thought.

Procedures form a bridge between more basic knowledge and the use of mathematics for solving routine problems, especially those encountered by many people in their daily lives. In essence a fluent use of procedures entails recall of sets of actions and how to carry them out. Students need to be efficient and accurate in using a variety of computational procedures and tools. They need to see that particular procedures can be used to solve entire classes of problems, not just individual problems.

Knowledge of concepts enables students to make connections between elements of knowledge that, at best, would otherwise be retained as isolated facts. It allows them to make extensions beyond their existing knowledge, judge the validity of mathematical statements and methods, and create mathematical representations.

Recall	Recall definitions; terminology; number properties; geometric properties; and notation (e.g., $a \times b = ab$, $a + a + a = 3a$).
Recognize	Recognize mathematical objects, e.g., shapes, numbers, expressions, and quantities. Recognize mathematical entities that are mathematically equivalent (e.g., equivalent familiar fractions, decimals and percents; different orientations of simple geometric figures).
Compute	Carry out algorithmic procedures for $+$, $-$, \times , \div , or a combination of these with whole numbers, fractions, decimals and integers. Approximate numbers to estimate computations. Carry out routine algebraic procedures.
Retrieve	Retrieve information from graphs, tables, or other sources; read simple scales
Measure	Use measuring instruments; choose appropriate units of measurement.
Classify/Order	Classify/group objects, shapes, numbers, and expressions according to common properties; make correct decisions about class membership; and order numbers and objects by attributes.

*From : http://timss.bc.edu/timss2011/downloads/TIMSS2011_Frameworks-Chapter1.pdf (October 2010)

Applying:

The applying domain involves the application of mathematical tools in a range of contexts. The facts, concepts, and procedures will often be very familiar to the student, with the problems being routine ones. In some items aligned with this domain, students need to apply mathematical knowledge of facts, skills, and procedures or understanding of mathematical concepts to create representations. Representation of ideas forms the core of mathematical thinking and communication, and the ability to create equivalent representations is fundamental to success in the subject.

Problem solving is central to the applying domain, but the problem settings are more routine than those aligned with the reasoning domain, being rooted firmly in the implemented curriculum. The routine problems will typically have been standard in classroom exercises designed to provide practice in particular methods or techniques. Some of these problems will have been in words that set the problem situation in a quasi-real context. Though they range in difficulty, each of these types of “textbook” problems is expected to be sufficiently familiar to students that they will essentially involve selecting and applying learned facts, concepts, and procedures.

Problems may be set in real-life situations, or may be concerned with purely mathematical questions involving, for example, numeric or algebraic expressions, functions, equations, geometric figures, or statistical data sets. Therefore, problem solving is included not only in the applying domain, with emphasis on the more familiar and routine tasks, but also in the reasoning domain.

Select	Select an efficient/appropriate operation, method, or strategy for solving problems where there is a known procedure, algorithm, or method of solution.
Represent	Display mathematical information and data in diagrams, tables, charts, or graphs, and generate equivalent representations for a given mathematical entity or relationship.
Model	Generate an appropriate model, such as an equation, geometric figure, or diagram for solving a routine problem.
Implement	Implement a set of mathematical instructions (e.g., draw shapes and diagrams to given specifications).
Solve Routine Problems	Solve standard problems similar to those encountered in class. The problems can be in familiar contexts or purely mathematical.

Reasoning:

Reasoning mathematically involves the capacity for logical, systematic thinking. It includes intuitive and inductive reasoning based on patterns and regularities that can be used to arrive at solutions to non-routine problems. Non-routine problems are problems that are very likely to be unfamiliar to students. They make cognitive demands over and above those needed for solution of routine problems, even when the knowledge and skills required for their solution have been learned. Non-routine problems may be purely mathematical or may have real-life settings. Both types of items involve transfer of knowledge and skills to new situations, and interactions among reasoning skills are usually a feature.

Problems requiring reasoning may do so in different ways, because of the novelty of the context or the complexity of the situation, or because any solution to the problem must involve several steps, perhaps drawing on knowledge and understanding from different areas of mathematics. Even though of the many behaviors listed within the reasoning domain are those that may be drawn on in thinking about and solving novel or complex problems, each by itself represents a valuable outcome of mathematics education, with the potential to influence learners' thinking more generally. For example, reasoning involves the ability to observe and make conjectures. It also involves making logical deductions based on specific assumptions and rules, and justifying results.

Analyze	Determine, describe, or use relationships between variables or objects in mathematical situations, and make valid inferences from given information.
Generalize/ Specialize	Extend the domain to which the result of mathematical thinking and problem solving is applicable by restating results in more general and more widely applicable terms.
Integrate/ Synthesize	Make connections between different elements of knowledge and related representations, and make linkages between related mathematical ideas. Combine mathematical facts, concepts, and procedures to establish results, and combine results to produce a further result.
Justify	Provide a justification by reference to known mathematical results or properties.
Solve Non-routine Problems	Solve problems set in mathematical or real life contexts where students are unlikely to have encountered closely similar items, and apply mathematical facts, concepts, and procedures in unfamiliar or complex contexts.

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