# 2006 HSC Notes from the Marking Centre Engineering Studies

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# Contents

# 2006 HSC NOTES FROM THE MARKING CENTRE ENGINEERING STUDIES

## Introduction

This document has been produced for the teachers and candidates of the Stage 6 course in Engineering Studies. It provides comments with regard to responses to the 2006 Higher School Certificate examination, indicating the quality of candidate responses and highlighting the relative strengths and weaknesses of the candidature in each section for each question.

This document should be read along with the relevant syllabus, the 2006 Higher School Certificate examination, the marking guidelines and other support documents that have been developed by the Board of Studies to assist in the teaching and learning of Engineering Studies.

## General Comments

In 2006, 1408 candidates attempted the Engineering Studies examination.

Teachers and candidates should be aware that each examination includes a number of different question styles. These range from questions that require the simple recall of knowledge through to those that expect candidates to respond by integrating the knowledge and skills they have developed through a comprehensive understanding of the entire course.

## Section I

| Question | Correct Response |
|---|---|
| 1 | A |
| 2 | C |
| 3 | D |
| 4 | D |
| 5 | C |
| 6 | B |
| 7 | C |
| 8 | A |
| 9 | A |
| 10 | B |

## Section II

### General Comments

Overall, responses indicated that the majority of candidates had a good grasp of engineering concepts, appropriate for Higher School Certificate candidates. Candidates need to be aware that the answer space allocated for each question is a guide to the length of the required response.
Candidates are also advised that marks are awarded for correct method even when incorrect answers are given.

### Question 11 – Historical and Societal Influences, and the Scope of the Profession

(a) Most responses provided a range of examples based on engineered solutions to problems or products to demonstrate how high standards of safety may be maintained or improved by engineers. A smaller number of responses described how the engineering workplace may be made safer by the work of engineers.

Common responses in the 'design stage' included: researched selection of materials based on design requirements, the analysis of forces and stresses, the application of safety factors to stress calculations, the application of current Australian Standards, the testing of materials and prototyping.
Correct responses for the 'construction/manufacturing stage' included: testing of manufactured components, the use of components and materials that fall within the design specifications, appropriate project construction management and ensuring that Occupational Health and Safety guidelines are met within the workplace.
Correct responses during the 'service life' were less varied, mainly concentrating on regular and/or planned maintenance programs or the replacement of components. Many responses indicated a lack of understanding of the engineer's responsibility once the engineered solution is in service.

(b) (i) Responses to this question revealed a varied and in-depth knowledge of historical aspects for engineered solutions. Some of the engineered solutions described included mobile telecommunications, improved public transportation systems, bio-medical products such as pacemakers and cochlea implants, civil structures (buildings, bridges, and dams), lifting devices, utilities/services (power, water, and sewerage) and descriptions of various aeronautical solutions. A number of responses identified the solution but were unable to provide a clear and concise description of how it was achieved.

(ii) Many responses did not clearly identify an ethical issue. Responses often described a solution to an engineering issue without specifically identifying an ethical dilemma behind the issue.

(c) The majority of responses identified two materials, such as steel, aluminium, polymers, concrete or timber and then described how they may be recycled or reused. Few responses were able to clearly link how the recycled or reused materials are considered during the design phase.

## Question 12 – Civil Structures

(a) (i) Most responses correctly identified four sources of applied loads that would act on the enclosed walkway and therefore be considered during the design stage. Weaker responses demonstrated a lack of understanding of the difference between applied loads and internal stresses.

(ii) Many responses correctly identified a decrease in ductility and an increase in strength properties. Common errors included the identification of only one property or incorrectly associating an increase in brittleness with improved toughness.

(b) (i) Most responses carefully calculated the two reactions. The common error in a number of responses came from using distances not consistent with the given diagram.

(ii) Responses using the 'method of section' process were generally more successful than the 'method of joint' process in arriving at the correct answer. Incorrect responses included using inconsistent perpendicular distances or misunderstanding the nature of the force in the member leading to an incorrect identification of the internal force as tensile.

(c) A correct response required the linking of any advantages related to the truss structure and the local conditions / application of the truss. The majority of responses outlined one advantage of truss structures but then did not attempt to justify the selection of the truss for this particular application.

## Question 13 – Personal and Public Transport

(a) Better responses described the need for soaking in the austenitic range. A number of responses displayed good knowledge of heat treatment but described an inappropriate process. A significant number of responses described properties or structural changes but not the process required. Candidates are reminded to read the question thoroughly and answer the question asked. In weaker responses, terminology was mismatched to the process described. Appropriate temperatures required for heat treatment were poorly expressed or often omitted.

(b) (i) Better responses often included diagrams displaying a clear understanding. Weaker responses described either changes in properties or appearance and omitted the structural changes associated with an understanding of cross-linking of polymers.

(ii) Responses generally revealed a sound understanding of the service properties of tyres and were creative in suggesting reasonable materials. A variety of materials was suggested and valid justifications for their inclusion were given, even though the material chosen may have been incorrect.

(c) The concept of power was well understood with most responses displaying correct methods and/or solutions. Weaker responses included incorrect conversions of quantities for inclusion in equations or the omission of gravity, time or distance. Some responses calculated the power for one box but did not consider the twenty-five boxes.

(d) The concept of power out and power in (efficiency) was not well represented. A significant number of responses displayed skills in manipulating one efficiency value, but did not correctly include the second efficiency.

A significant number of responses applied logical reasoning, without formulae, to solve the problem and arrive at the correct response. Candidates are encouraged to show all necessary working, because even if a student answers (b) incorrectly, marks may be awarded for appropriate working.

**Question 14 – Lifting Devices**

(a) (i) Most responses correctly substituted values from the data provided into the correct formula. Poorer responses reflected difficulty in converting the values supplied for force and area into SI units for use in calculations: for example, converting $mm^2$ to $m^2$ and kN to N.

(ii) The majority of responses opted for an analytical approach, although a graphical response was probably the easier one. A significant number of responses did not correctly identify the placement of forces and their direction in relation to 'Strut A'.

(b) (i) The correct response required either the supplied pressure to be divided by the factor of safety or the calculated load to be divided by the factor of safety. Weaker responses did not use the factor of safety or incorrectly used the cross-sectional area in calculations.

(ii) Better responses identified a synthetic rubber (elastomer) as the material and nominated resilience, chemical/oil resistance, flexibility/withstands pressure as appropriate properties. Weaker responses incorrectly identified either ferrous or non-ferrous metals or fibre-reinforced polymer (FRP) as a suitable material.

(c) Most responses correctly identified an appropriate method such as forging or cold forming with rapid mass production or accurate sizing as correct justifications.
Poorer responses included machining and die casting as suitable processes.

**Question 15 – Aeronautical Engineering**

(a) Best responses linked airflow and the use of ailerons in controlling the plane. A large number of responses used detailed diagrams to assist the explanations. A significant number of weaker responses mistook ailerons for flaps and explained how changing the shape of the wing would provide lift. Weaker responses also displayed incorrect terminology and lack of understanding of airplane dynamics.

(b) (i) Better responses identified a suitable non-destructive test and then described either the process or how the defect was displayed, depending on the type of non-destructive test. A significant number of weaker responses simply identified a type of test without describing the process involved or chose an inappropriate external test, such as dye penetrant.

(ii) Better responses often stated the defects in bullet-point form. However, a large number then went on to give an explanation for this type of failure. A significant number of responses gave the mechanism for failure such as fatigue or creep rather than the specific defect that was being asked for.

(c) Assembly of the two components was handled very well. However, a large number of responses displayed incorrect drawing standards for screw threads in both views.

Other common incorrect drawing standards included a lack of understanding of what a 'half-section' requires, the principles of sectioning components, the repositioning of holes to the sectioned surface and the appearance of drill-hole ends and fillets.

(d) Very few responses demonstrated the use of graphical analysis techniques to solve this problem. A number of responses that did attempt a graphical solution displayed a high degree of inaccurate measurement with regards to angles and scale. Analytical solutions were the popular method used: however, there was much confusion as to the correct angles to be used, for example, using cosine or tan instead of correctly using sine , how to apply the various loads in the problem and using inappropriate formula related to small angles (regarded as less than 5° of climb or descent). A significant number of responses failed to include units as part of the answer.

**Question 16 – Telecommunication**

(a) (i) Better responses correctly related higher frequency waves and shorter wavelengths to shorter antenna length requirements. Many responses did not refer to antenna length: a specific part of the question. A high proportion of responses reflected a lack of knowledge of the relationship between the wavelength of radio waves and antenna size.

(ii) Most responses indicated a lack of understanding that the higher energy radio waves (VHF and UHF) can pass through the ionosphere into space while the lower energy high frequency (HF) waves are reflected. This makes HF radio signals better for long distance terrestrial transmission than the higher frequency waves.

(b) (i) Better responses included more efficient transmission, multiplexing and smaller antenna length. Weaker responses described the process of modulation rather than correctly explaining the purpose of modulation. A frequent incorrect response provided a description of a modem and the process of converting analogue to digital.

(ii) Correct responses indicated that a radar transmission uses a discrete signal and thus does not need to be modulated with an information wave.

(c) Most candidates answered this question correctly. Common incorrect responses were the requirement to use protective clothing around radar transmission areas and the need to lead-line windows and buildings.

(d) Most responses provided either isometric or oblique sketches of the push switch. Sketches that gained full marks showed the three distinct segments (cylinder, frustum and hexagonal prism) of the push switch in the correct positions and proportions. Common errors included sketching the segments out of proportion, not showing all three segments or not completing a recognised form of pictorial drawing.

## Section III

### Question 17

(a) Many candidates correctly answered this part. However, some responses incorrectly interpreted the bending moment as the load and simply halved it to find the reactions without understanding the concepts or calculations involved in determining bending moments. Some responses demonstrated a lack of understanding in conversion of force (N) to a mass (kg) as required.

(b) (i) Most responses correctly explained why galvanising is effective in protecting steel from corrosion.

(ii) Most responses listed appropriate service properties such as wear resistance, weather resistance, non-toxic and absorbs impact energy. Better responses listed four service properties. Some responses listed different terms indicating similar service properties, eg flexible and elastic.

(c) Many responses achieved full marks for this part. However, some responses confused the introduction with a synopsis or abstract. The analysis section was the most poorly answered with many responses simply restating the question or giving examples of issues without describing the purpose of the analysis.

### Question 18

(a) A small numbers of responses were able to gain full marks because they showed how the two motors were or could be integrated to increase efficiency in the hybrid vehicle.
Better responses described the concept of the two energy sources, and went on to explain issues including regenerative braking / recharging principles and/or driving conditions when each energy source would be used. Some responses also described the savings made from using electrical/battery power in stop/start driving in city conditions.

(b) Better responses identified appropriate criteria and clearly explained why an engineer would select High Density Polyethylene (HDPE) as the tank material. Many responses correctly nominated two criteria for using the HDPE tank but failed to explain how or why an engineer would recommend the material for the application.

(c) Better responses clearly articulated how an engineer might analyse the available data, weight the selected criteria and then finally make a decision based on all the available information. Many responses correctly identified key criteria; however only a small number then correctly explained the processes that an engineer could use to make an informed decision as to the 'best motor for the hybrid vehicle'.
Some responses listed attributes of the selected motor without addressing how the attributes were selected and used to aid a final decision.

(d) The majority of responses successfully listed two advantages of computer assisted drawing (CAD). Some responses indicated a poor understanding of the drawing skills that are common in engineering and the benefits of computer assisted drawing.

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# 2006 HSC Engineering Studies
# Marking Guidelines

## Section II

### Question 11 (a)

*Outcomes assessed: H5.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Describes how engineers address safety in all three stages | 3 |
| • Gives limited responses | 2 |
| • Gives a limited response | 1 |

### Question 11 (b) (i)

*Outcomes assessed: H4.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Identifies an issue AND describes solution | 2 |
| • Identifies an issue AND provides a limited description of the solution | 1 |

**Question 11 (b) (ii)**

*Outcomes assessed: H1.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Identifies an ethical issue AND describes a strategy | 2 |
| • Identifies an ethical issue<br>OR<br>• Describes a strategy | 1 |

**Question 11 (c)**

*Outcomes assessed: H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Explains how recycling of materials is incorporated into design by using TWO examples | 3 |
| • Explains how recycling of materials is incorporated into design by using ONE example<br>OR<br>• Provides TWO examples of recycling with a limited relationship to engineering design | 2 |
| • Provides TWO example of recycling | 1 |

**Question 12 (a) (i)**

*Outcomes assessed: H2.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Gives FOUR sources of applied loads | 2 |
| • Gives TWO to THREE sources of applied loads | 1 |

**Question 12 (a) (ii)**

*Outcomes assessed: H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Lists TWO changes to properties | 1 |

**Question 12 (b) (i)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses a correct method and/or gives correct solution | 2 |
| • Uses a correct method with error/s | 1 |

**Question 12 (b) (ii)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses a correct method and/or gives correct solution | 2 |
| • Uses a correct method with error/s | 1 |

**Question 12 (c)**

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Justifies the selection of a truss in this situation | 3 |
| • Provides a limited justification OR describes two advantages | 2 |
| • Provides one general advantage of trusses | 1 |

**Question 13 (a)**

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Describes a suitable process | 2 |
| • Identifies a suitable process | 1 |

**Question 13 (b) (i)**

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Gives a correct reason | 1 |

**Question 13 (b) (ii)**

*Outcomes assessed: H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Names a suitable material and justifies its inclusion | 2 |
| • Names a suitable material<br>OR<br>• Justifies its inclusion in the composite | 1 |

**Question 13 (c)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses correct method and/or gives correct solution | 3 |
| • Uses correct method with minor errors | 2 |
| • Uses correct method with a significant error | 1 |

**Question 13 (d)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses correct method and/or gives correct solution | 2 |
| • Uses correct method with errors | 1 |

**Question 14 (a) (i)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses correct method an/or gives correct solution | 2 |
| • Uses correct method with error | 1 |

**Question 14 (a) (ii)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses an appropriate method to determine the correct solution | 2 |
| • Uses an appropriate method with errors | 1 |

**Question 14 (b) (i)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses correct method and/or gives correct solution | 2 |
| • Uses correct method with errors | 1 |

**Question 14 (b) (ii)**

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Identifies an important property and names appropriate material | 2 |
| • Identifies an important property<br>OR<br>• Names an appropriate material | 1 |

**Question 14 (c)**

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Identifies suitable manufacturing technique and provides justification | 2 |
| • Identifies suitable manufacturing technique without justification<br>OR<br>• Provides relevant comments in regard to choosing a technique but identifies an inappropriate technique | 1 |

**Question 15 (a)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Gives a correct explanation linking airflow and aircraft control | 3 |
| • Gives a limited explanation linking airflow and aircraft control<br>OR<br>• Gives a good explanation of airflow or control but does not link them | 2 |
| • Gives a limited explanation of either airflow or control | 1 |

**Question 15 (b) (i)**

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Describes a suitable method of testing | 2 |
| • Identifies a suitable method of testing<br>OR<br>• Describes a non-suitable method of testing | 1 |

**Question 15 (b) (ii)**

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Lists TWO appropriate defects | 2 |
| • Lists ONE appropriate defect | 1 |

**Question 15 (c)**

*Outcomes assessed: H3.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides correct assembly and proportion of components with correct standards | 5 |
| • Provides correct assembly and proportion of components with substantially correct standards | 4 |
| • Provides correct assembly and proportion of components with some correct standards | 3 |
| • Provides basic assembly and proportion of components | 2 |
| • Provides limited assembly and proportion of components | 1 |

**Question 15 (d)**

*Outcomes assessed: H3.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses appropriate method and/or gives correct solution | 3 |
| • Uses appropriate method with minor errors | 2 |
| • Uses appropriate method with significant errors | 1 |

**Question 16 (a) (i)**

*Outcomes assessed: H2.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides a sound explanation | 2 |
| • Provides a limited explanation | 1 |

**Question 16 (a) (ii)**

*Outcomes assessed: H2.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides a sound explanation | 2 |
| • Provides a limited explanation | 1 |

**Question 16 (b) (i)**

*Outcomes assessed: H2.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Explains a purpose using appropriate technical terms and concepts | 3 |
| • Explains a purpose in non-specific terms | 2 |
| • Explains the process rather than the purpose | 1 |

**Question 16 (b) (ii)**

*Outcomes assessed: H2.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides a sound explanation | 2 |
| • Provides a limited explanation or explains the basics of radar | 1 |

**Question 16 (c)**

*Outcomes assessed: H1.1, H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Describes TWO appropriate strategies | 2 |
| • Describes ONE appropriate strategy | 1 |

## Question 16 (d)

*Outcomes assessed: H3.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides a pictorial view to correct (or almost correct) size and shape | 4 |
| • Provides a substantially correct pictorial view, mostly complete | 3 |
| • Provides a pictorial view with some aspects correct | 2 |
| • Provides a limited and/or incomplete (pictorial) sketch | 1 |

# Section III

## Question 17 (a)

*Outcomes assessed: H3.1, H6.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Uses correct method and/or gives correct solution | 3 |
| • Uses correct method with minor errors | 2 |
| • Uses correct method with significant errors | 1 |

## Question 17 (b) (i)

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides an appropriate reason | 1 |

## Question 17 (b) (ii)

*Outcomes assessed: H1.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Lists FOUR service properties | 2 |
| • Lists TWO to THREE service properties | 1 |

## Question 17 (c)

*Outcomes assessed: H3.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides clear and relevant purpose for all FOUR sections | 4 |
| • Provides clear and relevant purpose for some of these sections<br>OR<br>• Addresses all sections with less relevant answers | 2–3 |
| • Limited answer | 1 |

**Question 18 (a)**

*Outcomes assessed: H2.2, H4.3*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides appropriate suggestions | 3 |
| • Provides some understanding of the hybrid systems | 2 |
| • Provides limited understanding of the hybrid systems | 1 |

**Question 18 (b)**

*Outcomes assessed: H6.1, H6.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Explains TWO appropriate criteria | 2 |
| • Explains ONE appropriate criteria | 1 |

**Question 18 (c)**

*Outcomes assessed: H1.2, H2.1*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides a clear outline that addresses conflicting criteria | 3 |
| • Provides a clear outline | 2 |
| • Provides a limited outline | 1 |

**Question 18 (d)**

*Outcomes assessed: H3.3, H4.2*

**MARKING GUIDELINES**

| Criteria | Marks |
|---|---|
| • Provides TWO appropriate advantages | 2 |
| • Provides ONE appropriate advantage | 1 |