Strategies for Open Book Questions using Higher Order Thinking Skills (HOTS)

by
Assoc. Prof. Dr. Hidayat Zainuddin

What is Open Book Examination?

1 It is an assessment method designed in a way that allows students to refer to their class notes, textbooks or other approved materials while answer questions.

2 Open book exams test students' ability to find and use information for problem solving and to deliver well-structured and well-presented arguments and solutions.

3 It can be conducted in different ways:
- Traditionally sit-down / limited-time exams
- Students are provided with the exam questions prior to sitting the formal exam
- Take home exams and returned within a specified period of time

MyUTeM

Why Open Book Exams?

1 Ideal for courses / programmes that especially aims at developing the skill of critical and creative thinking

3 -Testing Rote Learning VS Testing Thinking Skills
- **Testing Rote Learning** – To evaluate how much the students have memorized from repetition.
- **Testing Thinking Skills** – Focus on higher-order thinking (HOT), i.e. Apply (C3), Analyze (C4), Evaluate (C5) and Synthesize (C6).

4 If we are not interested in testing memorized information, why use closed book examinations?

2 To test students' ability to quickly find relevant information, and then to understand, analyze, apply knowledge and think critically

5 It reflects real life more accurately than closed-book exams

6 To prevent students from cramming

7 **Covid-19…!!**

Types of materials can be used in open book exams

1 Restricted Type

i) Students are permitted to bring into the examination room one or more **specific documents approved by the course instructor.**

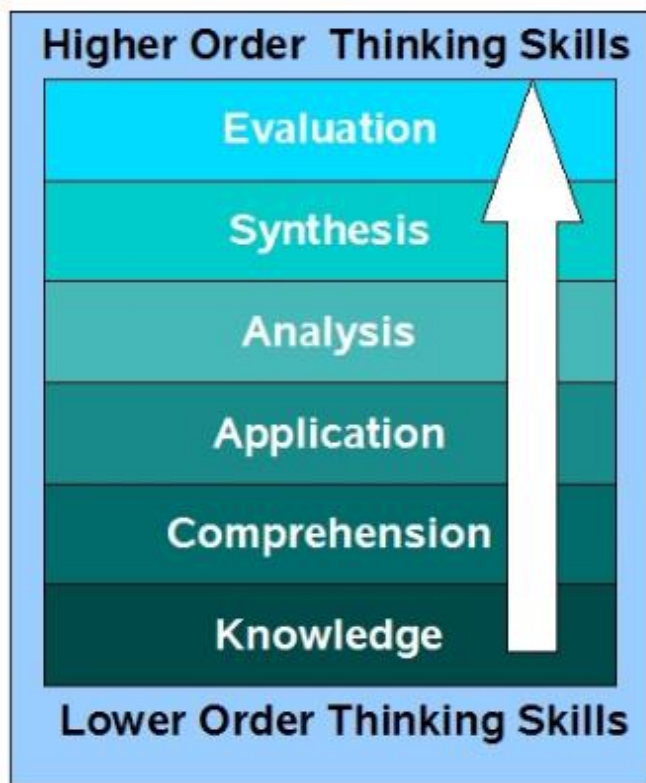ii) E.g. Formula sheets, tables or limited number of texts / papers / notes.

2 Unrestricted Type

i) Students are free to bring **whatever they like.**

ii) E.g. any books (with or without scribbles on the margin), lecture handouts of the course instructor, or their own handwritten notes without any restriction.
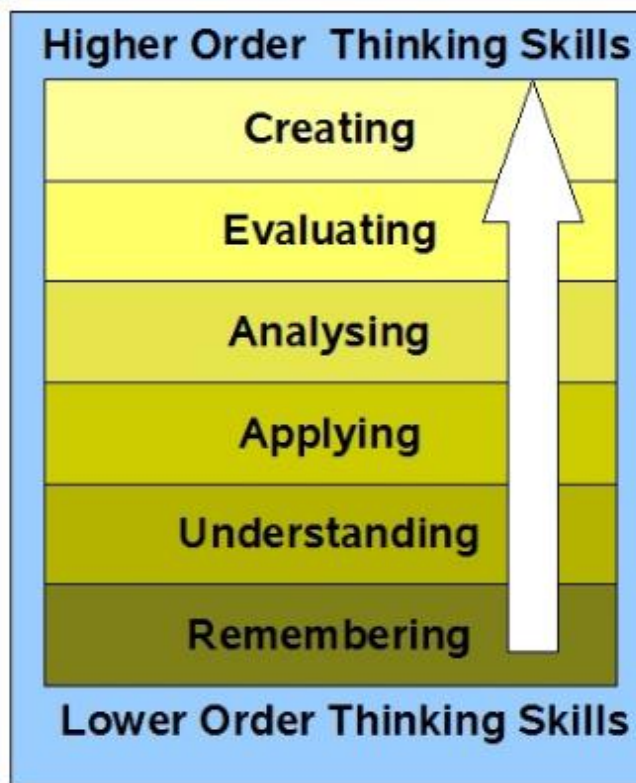
Academic Misconduct Issues

1) Adopt a new outlook - Not like conventional exams.

2) Open book exams develop an atmosphere of trust and honesty.

3) In fact, NO type of exam is completely misconduct proof.

4) No single standard set of rules for open book exams. You define the integrity / rules..!!

5) Some ways to offer integrity in open book exams are:
- Restricted vs Unrestricted materials
- Different sets of questions
- Reshuffle and random - for online test like MCQ
- Plagiarism check for essay-type take-home exams
- Realistic examination period and reflects the difficulty levels

MyUTeM

Bloom's Taxonomy

Original

Higher Order Thinking Skills
- Evaluation
- Synthesis
- Analysis
- Application
- Comprehension
- Knowledge

Lower Order Thinking Skills

Revised

Higher Order Thinking Skills
- Creating → C6
- Evaluating → C5
- Analysing → C4
- Applying → C3
- Understanding → C2
- Remembering → C1

Lower Order Thinking Skills

C3 → There is a grey area in the C3 level, where lower level cognitive thinking begins to transition to higher level cognitive thinking.

Open Ended vs Closed Ended

- A closed-ended question is one for which there are a limited number of acceptable answers, most of which will usually be anticipated by the instructor.

- An open question is one for which there are many acceptable answers, most of which will not be anticipated by the instructor.

- In principle, Open or Closed Ended can be both LOTS or HOTS questions.

	LOWER-LEVEL	HIGHER-LEVEL
CLOSED-ENDED	What is the definition of an adjective?	Based on the given data, discus the findings.
OPEN-ENDED	What is an example of an adjective?	Based on the given data, propose some ways that might be useful to improve the trend.

Consideration when designing open book exam questions

1 Design your questions based on the **Learning Outcomes** of the course.

2 Design your questions that reflects the **Higher-Order Thinking (HOT) level (C3-C6)**.

a) Questions that require students to **apply and make use** of the information from their textbook or notes **rather than simply requiring** them to locate and re-write this information.

b) Questions to **assess the interpretation and application of knowledge, comprehension skills, and critical thinking skills rather than only knowledge recall**.

c) Questions that require students to **apply critical reasoning skills** in response to the given problem or scenario.

d) Questions around **case-based problems or scenarios or make use of relevant qualitative or quantitative data** that require students to **apply the HOT skills.**

3 Design questions that are **suitable for the allocated time (realistic and manageable).**

MyUTeM

Some Guidelines / Ways of Developing HOTS Questions

1. Unguided questions

- Solve using any methods available

- Instead of asking several questions in steps, just ask 1 or 2 question/s that need to be solved using those steps

2. Making connections

- Provide several information to be digested

- Provide criteria / requirement to be considered

3. Scenario-based questions

- Problem-based scenarios or real-world cases

- Provide relevant qualitative or quantitative data

Some Guidelines / Ways of Developing HOTS Questions

4. Socratic-type questions

• Clarification questions – What does it mean by …? What do you think?

• Reason and evidence questions – Why? What is your justification?

• Implication questions – What is the probable effect?

• Viewpoint questions – How would you solve the problem? What is an alternative?

5. Open-ended questions

• Can be used at any Bloom's Level, but it is useful to upgrade the questions from C3 (Lower Level) to C3 (Higher Level)

6. Reversal questions

• Ask students reverse questions rather than normal questions taught in the class or typically available in the text book

Examples

Electric Circuit (BEKU 1223)

a) Referring to the circuit in Figure Q5(a), calculate the voltage across 2 Ω resistor when $V_m = 12\angle 0°$ using nodal analysis.
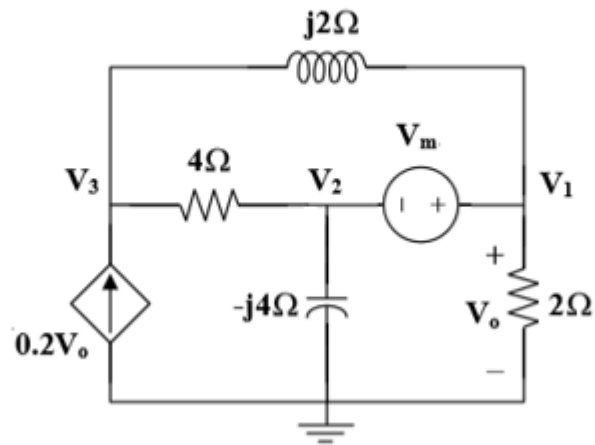
(12 marks)

Figure Q5(a)

Before: Level C3 (Lower)

a) Referring to the circuit in Figure Q5(a), calculate the voltage across 2 Ω resistor when $V_m = 12\angle 0°$.
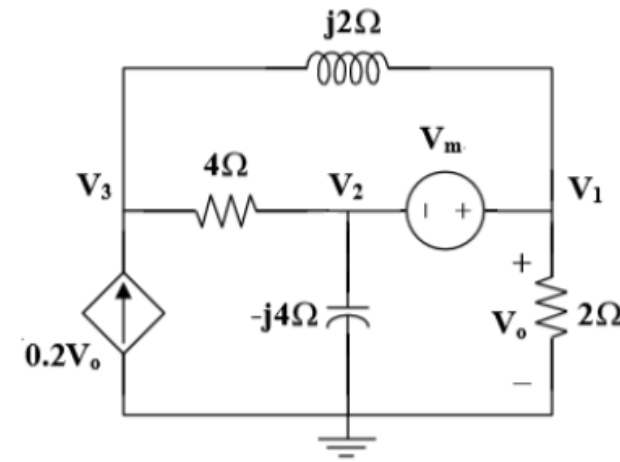
(12 marks)

Figure Q5(a)

After: Level C3 (Higher)

MyUTeM

Examples

Distribution System Design (BEKP 3683)

a) Based on your understanding,

    i)   Why we need protection in electrical system.

    ii)   Explain three (3) main criteria in power system protection design.

                                                  (6 marks)

Before: Level C2

a) Figure Q4(a) shows a single line diagram of electrical system from the main supply to a main distribution board (MSB). In case of any electrical fault at the MSB, it may cause cable failure from the transformer to the main distribution board . Therefore, as an engineer, you are required to propose solutions that can avoid the situation.
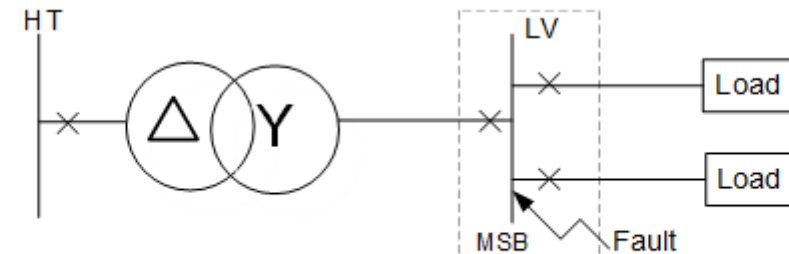
                                                 (6 marks)

Figure Q4 (a) Single line diagram of electrical system

After: Level C3 (Higher)

MyUTeM

Examples

Power Electronics (BEKE 3543)

a) A half-wave rectifier as shown in Figure Q1(a) has a 120 V_{rms}, 50 Hz AC source. Power absorbed by the load is 50 W. Determine the value of a filter capacitor to keep the peak-to-peak ripple across the load less than 1.5V.
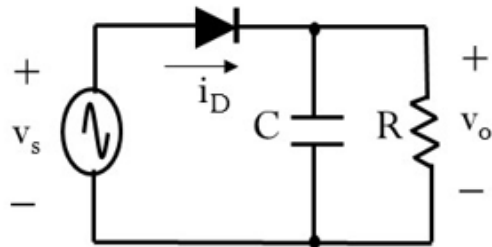
(3 marks)

Figure Q1(a): Half-wave rectifier

Before: Level C3 (Lower)

(a) You are given schematic diagram of two types rectifier with the same input AC voltage of 240 V_{rms}, 50 Hz and different load resistance R. You are required to make a theoretical evaluation on both rectifiers and choose the one that fulfil the requirement listed in Table Q1. The maximum current allowed to flow to the load is limited at 5A$_{rms}$.
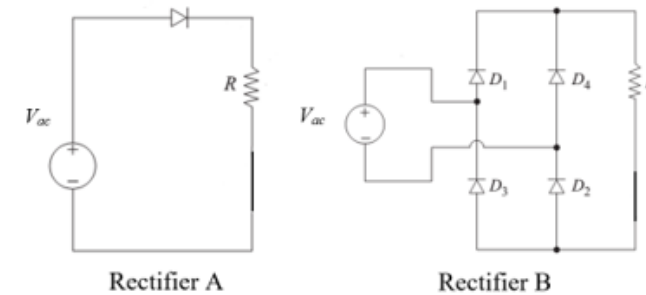

Rectifier A   Rectifier B

Figure Q1: Two types of rectifier

Table Q1: Rectifier operation requirement

Output power	≥ 1 kW
Power factor (at full load)	≥ 0.9

(12 marks)

After: Level C6

MyUTeM

Examples

High Voltage Engineering (BEKP 4883)

(b) With the aid of diagram, briefly explain the following:
  (i)   Ionization by collision.
                                                      (3 marks)

  (ii) Solid dielectric breakdown by surface tracking mechanism.
                                                      (3 marks)

  (iii) Solid dielectric breakdown by internal discharge mechanism.
                                                      (4 marks)

Before: Level C2

(a) Corona discharge can occur at power transmission lines as a result of ionization of air molecules. In your opinion, how does the elevation of transmission lines from sea level may affect the corona discharge? Discuss your answer in terms of the mean free path of charge particles and ionization process by collision of particles.
                                                      (10 marks)

(b) The insulation of a high voltage cable is contaminated with a tiny water droplet during its manufacturing process. Discuss the appropriate mechanism that may lead to insulation breakdown in long term due to this defect.
                                                      (15 marks)

After:
(a) Level C5
(b) Level C3 (Higher)

MyUTeM

Examples

Energy Utilization and Conservation (BEKP 4853)

b) Regulation 5 under Efficient Management of Electrical Energy Regulations 2008 (EMEER 2008) stated Obligation to submit information where licensee, supply authority or private installation licensee shall ensure that the information or documents provided are true, accurate and complete. List out **FOUR (4)** of the information that need to be submitted to the Energy Commission.

(4 marks)

c) After the notification from Energy Commission, the installation licences or consumer must follow the date of notification state under Regulation 7. Draw the timeline or milestone of the process start from the date of notification until report submission to the Energy Commission.

(8 marks)

A 5-star hotel in Port Dickson received a written notice dated 15 April 2019 from the Energy Commission (EC) under Sub-regulation 9(2) of Efficient Management of Electrical Energy Regulations 2008 (EMEER 2008), whereby the hotel is no longer required to further submit the information and report as specified in Regulation 6 of EMEER 2008. However, a few months later, the notice under Sub-regulation 9(2) was withdrawn.

i) Briefly discuss **TWO (2)** possible reasons for the issuance of the withdrawal notice by the EC. Support your answer with examples.

(8 marks)

ii) In order to avoid such withdrawal, suggest and elaborate the appropriate actions should be taken earlier by the Registered Electrical Energy Manager (REEM) with respect to the reasons given in (i).
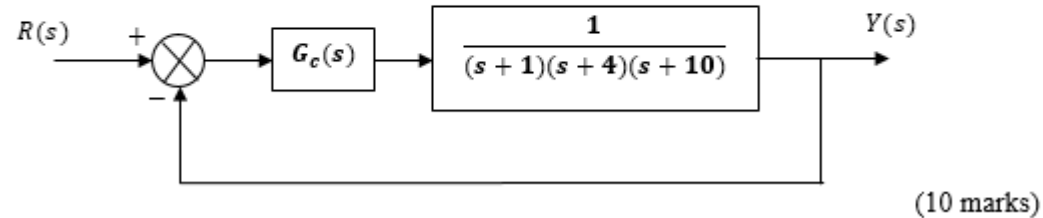
(12 marks)

Before:
(b) Level C1
(c) Level C2

After: Level C5

MyUTeM

Examples

Control and Instrumentation (BEKC 3663)

(a) Given a system as shown in Figure 1. Prove that by using a lag compensator, $G_c(s)$, the steady-state error of the system can be improved by factor 2.

$$R(s) \xrightarrow{+} \bigotimes \xrightarrow{} \boxed{G_c(s)} \xrightarrow{} \boxed{\dfrac{1}{(s+1)(s+4)(s+10)}} \xrightarrow{} Y(s)$$

(10 marks)

Before: Level C3 (Higher)

(a) The objective of designing lag compensator is to improve the steady-state error without significantly affecting the transient response compared to the simple gain K controller. With your own example of any system, prove the statement.

(10 marks)

After: Level C3 (Higher: Open-ended)

MyUTeM

Examples

Energy Utilization and Conservation (BEKP 4853)

a) You are appointed as a consultant to conduct an energy audit at an office building. Figure Q4(a) shows the energy consumption for 1-year period with the baseline is set from March 2017. Table Q4(a) shows the load apportioning at the office. The gross floor area (GFA) of the office is 22000 m². For energy conservation measure (ECM), you are proposing to reduce the lighting intensity of the office to 14 W/m², which is strictly follow the Malaysia Standard MS 1525. Perform the energy saving analysis to demonstrate the expected improvement in terms of building energy index (BEI), total energy consumption and electricity bill after implementing the ECM. Given, the rate of electricity cost is RM 0.38/kWh, the office is operated from Monday to Friday, 8:00 am until 6:00 pm, with 2-week public holiday annually and no cost incurred in the ECM.
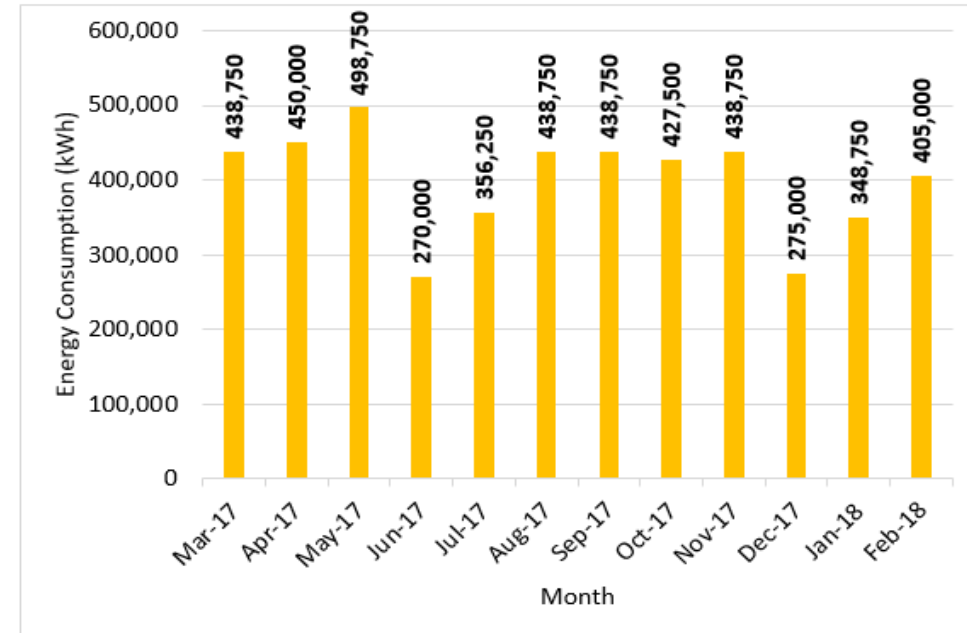
(8 marks)

Figure Q4(a): Energy consumption for 1-year period from March 2017 to February 2018

Level C4

Table Q4(a): Load apportioning

No.	Type of Load	Consumption Percentage (%)
1.	Air-conditioning	60
2.	Lighting	22
3.	Computer	14
4.	Others	4

MyUTeM

Examples

Differential Equations (BMCG 1013)

(c) A second order linear differential equation is given as:

$$y''+4y = 4x^2 - 6, \qquad y(0) = 0, \qquad y'(0) = -2$$

i. By using the method of undetermined coefficients, find the solution for the problem above.

(10 marks)

Level C3 (Lower)

ii. A spring-mass system is given as:

$$y''+4y = x^{12}e^{-7x}, \qquad y(0) = 0, \qquad y'(0) = -2$$

Explain why the method of undetermined coefficient is not suitable to solve this problem and explain briefly the steps of one other method to solve the problem.

(3 marks)

Level C5

Examples

Differential Equations (BMCG 1013)

A metal rod of length 2π cm has initial temperature function $f(x) = 3\sin x$ and its two ends are held at temperature zero for all time $t > 0$.

The heat equation is given as:

$$5\frac{\partial^2 u}{\partial x^2} - \frac{\partial u}{\partial t} = 0 \text{ for } 0 < x < 2\pi \text{ and } t > 0$$

Boundary conditions: $u(0,t) = u(2\pi,t) = 0$,

Initial conditions: $u(x,0) = 3\sin x$

(a) By using the method of separation of variables, calculate the general temperature $u(x,t)$ for all cases, $k = \lambda^2, k = 0$, and $k = -\lambda^2$.

(12 marks)

(b) The solutions when $k = 0$ and $k = \lambda^2$ are found to be trivial. Therefore, by using the given conditions, calculate the solution of the partial differential equation for the nontrivial case, which is for $k = -\lambda^2$ only.

(10 marks)

(c) The heat equation above can also be solved using finite difference numerical methods. Explain the mathematical steps, together with suitable interval and subintervals, to evaluate the solution at position 0.75π from the end of the metal rod and at time 3 seconds. **DO NOT** calculate the solution.

(3 marks)

Level C5

Level C3 (Higher)

MyUTeM

Energy Utilization and Conservation (BEKP 4853) - MCQ

10. Which of the following are TRUE to qualify a UTeM student to apply for registration as an electrical energy manager through UTeM-ST Professional Certification Programme?

I. The student must obtain a minimum CGPA of 2.5.

II. The student must obtain a minimum CGPA of 2.75.

III. The student must obtain a minimum grade of B+ for the Energy Utilization and Conservation course and manage to submit and undergone the assessment of the PBL assignments.

IV. The student must obtain a minimum grade of B for the Energy Utilization and Conservation course and manage to submit and undergone the assessment of the PBL assignments.

A. I and III

B. I and IV

C. II and III

D. II and IV

Level C1

10. Ali and Ahmad are Malaysian citizens, aged 23 years old. They received their Bachelor of Electrical Engineering from UTeM in year 2019. During their study, they undertook the Energy Utilization and Conservation course.

Ali's final CGPA is 2.5, obtained B+ for the Energy Utilization and Conservation course but did not manage to submit and undergone the assessment of the PBL assignments.

Ahmad's final CGPA is 2.5, obtained B+ for the Energy Utilization and Conservation course and managed to submit and undergone the assessment of the PBL assignments.

Which of the followings are TRUE on the process for them to apply for registration as an electrical energy manager?

I. Both of them are required to submit their endorsed 1-year experience report related to electrical energy management at an installation under sub-regulation 12(1)(a)(i) of EMEER 2008.

II. Ali is required to submit his endorsed 1-year experience report related to electrical energy management at an installation under sub-regulation 12(1)(a)(i) of EMEER 2008. But Ahmad does not have to as he has fulfilled sub-regulation 12(1)(b).

III. Ali is required to attend an interview conducted by Energy Commission under sub-regulation 12(2) of EMEER 2008, but Ahmad does not have to as he has fulfilled the course requirement.

IV. Both of them are required to attend an interview conducted by Energy Commission under sub-regulation 12(2) of EMEER 2008.

A. I and III

B. I and IV

C. II and III

D. II and IV

Level C3 (Higher)

Misconceptions about open book exams (Students must know..!!)

1. Open book exams are a breeze

- Actually, open book exams are **not an easy option.**
- Answering the questions well **requires more than just copying information straight from texts.**
- In open book exams, it is how you **locate, apply and use the information** that is important.
- For example, having access to a textbook can stop you from giving a wrong answer if you can't remember a fact or formula, but just getting that fact correct won't get you good marks.
- Open-book exams are likely to give the impression that one can find all the answers during the examination. The fact is exactly the opposite. **Resources must be used rarely and only under emergency.**

2. You don't have to study

- Probably the **biggest misconception**.
- You **should study** just as you would for any other exam. Having books and notes to refer to might mean you don't have to memorize as much information, but you still need to be able to apply it effectively.
- You must **fully understand and be familiar with the content and materials** of the course so you can find and use the appropriate information.
- Open book exams will probably be timed. So, you need to **quickly find the relevant information** in the resources you have.

myUTeM

Misconceptions about open book exams (Students must know..!!)

3. You can just copy straight from the book!

- You **can't copy chunks of text directly** from textbooks or notes. This is **plagiarism**.
- You must be **able to find, interpret and apply the information in your sources** to the exam questions.
- When necessary, you need to reference as well, just as you would for any other assignment.

4. The more materials the better!

- Only take **what you need.**
- **Stacks of books won't necessarily guarantee your performance,** and you **won't have time for extensive reading.**
- **Too many materials can end up distracting** you and **crowding up** your workspace.
- **Carefully select** your materials and **organize** them **for quick reference.**

Ref: https://student.unsw.edu.au/open-book-and-take-home-exams

MyUTeM

References

Links to Open Book Exam

https://melbourne-cshe.unimelb.edu.au/__data/assets/pdf_file/0010/3341944/closed-book-to-open-book-exam_final.pdf

https://student.unsw.edu.au/open-book-and-take-home-exams

https://youthincmag.com/open-book-exams-for-engineering

https://www.newcastle.edu.au/__data/assets/pdf_file/0006/268980/Open-Book-Exams.pdf

https://www.tandfonline.com/doi/full/10.3108/beej.2004.03000004

https://www.geteducated.com/elearning-education-blog/3-reasons-why-you-need-to-study-for-an-open-book-test/

http://www.iiserpune.ac.in/~mohanan/educ/openbook.pdf

https://www.researchgate.net/post/Can_open-book_tests_examinations_address_the_problem_of_cheating_How_about_allowing_students_to_Google_answers

http://www.kevinhouston.net/blog/2020/03/mathematics-take-away-open-book-assessment/

Links MCQ – HOT Question

https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1355&context=pare

https://www.mcgill.ca/skillsets/files/skillsets/mcq_handout3.pdf

https://teaching.uwo.ca/pdf/programs/Writing-Higher-Order-MCQ-Fall-2018.pdf

http://theelearningcoach.com/elearning_design/multiple-choice-questions/

https://cft.vanderbilt.edu/guides-sub-pages/writing-good-multiple-choice-test-questions/

Open-ended vs Closed-ended Questions
https://citl.illinois.edu/citl-101/teaching-learning/resources/teaching-strategies/questioning-strategies
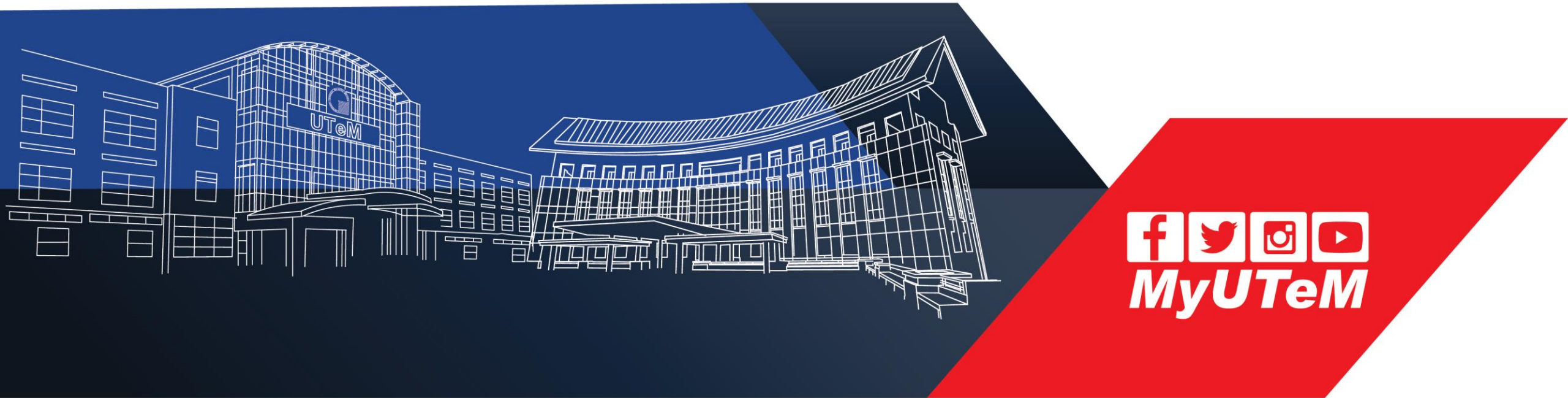

Bloom's Taxonomy
https://sites.google.com/site/4newfrndzbloomstax/hot-and-lot
https://dataworks-ed.com/blog/2014/10/higher-order-questions/
https://www.mcgill.ca/skillsets/files/skillsets/mcq_handout3.pdf

MyUTeM

Acknowledgement

Thank You

www.utem.edu.my

MyUTeM