GUIDELINES FOR DEVELOPMENT OF OPEN- ENDED QUESTIONS

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1. GARIS PANDUAN PELAKSAAN PEPERIKSAAN AKHIR DALAM TALIAN
2. LAMPIRAN 1: GARIS PANDUAN PELAKSAAN PEPERIKSAAN AKHIR DALAM TALIAN
3. LAMPIRAN 1: ONLINE TEACHING AND LEARNING AND ASSESSMENT GUIDELINE

MOTIVATIONS (WHY?)

- ALL INSTITUTIONS OFFERING ENGINEERING PROGRAMS ARE FACED WITH SIGNIFICANT CHALLENGES, ESPECIALLY IN PREPARING STUDENTS SO THAT THEY CAN RECEIVE INFORMATION, LEARN THE TECHNOLOGY, THE PRINCIPLES AND PRACTICE OF ENGINEERING AS WELL AS ADAPTING TO THE RAPIDLY CHANGING NEEDS TO COMPETE GLOBALLY. CRITERIA AND TARGETS SET BY THE ENGINEERING ACCREDITATION COUNCIL (EAC) AND THE MALAYSIAN QUALIFICATIONS AGENCY (MQA) STIPULATE THAT THESE STUDENTS MUST BE ABLE TO PROCESS THE INFORMATION ACTIVELY AND CRITICALLY, EVALUATE THEM IN ORDER TO ACHIEVE THE HIGH LEVEL OF PROFESSIONAL SKILLS. APART FROM THE USE OF TEACHING AND LEARNING STRATEGIES, ASSESSMENT METHODS, SUCH AS OPEN-ENDED QUESTIONS FROM THE HIGHER LEVEL OF BLOOM'S TAXONOMY CAN BE USED TO DEVELOP THE NECESSARY PROFESSIONAL SKILLS.

"HOW TO CONSTRUCT OPEN ENDED QUESTIONS", PROCEDIA - SOCIAL AND BEHAVIORAL SCIENCES 60 (2012) 456 – 462 HAFIZAH HUSAIN, BADARIAH BAISB, AINI HUSSAINB, SALINA ABDUL SAMAD

MOTIVATIONS (WHY?)

- ONLINE MODE OF ASSESSMENT - INTEGRITY

- RESPONSIBILITY OF ALL LECTURERS TO ENSURE THAT MEASUREMENTS OF COURSE LEARNING OUTCOMES (CLO) ARE:
  - RELIABILITY
  - ACCURACY
  - RELEVANCY

INTRODUCTION

- ASKING QUESTIONS IS A BASIC WAY TO GATHER INFORMATION.
- A WAY TO ENGAGE “PEOPLE” IN A “CONVERSATION”.
- IN EDUCATION, ASKING QUESTIONS ARE TOOL IN THE ASSESSMENT OF STUDENTS’ KNOWLEDGE ON SPECIFIC TOPICS AND SUBJECTS.
- ASKING THE RIGHT QUESTIONS, IN THE RIGHT MANNER WOULD ENSURE THAT ACCURATE AND RELIABLE ANALYSES AND CONCLUSIONS COULD BE EXTRACTED FROM THE STUDENTS BASED ON ANSWERS GIVEN.

CLOSED ENDED VS OPEN ENDED

- CLOSED-ENDED QUESTIONS ARE QUESTIONS THAT CAN ONLY BE **ANSWERED BY SELECTING FROM A LIMITED NUMBER OF OPTIONS**, USUALLY MULTIPLE-CHOICE, 'YES' OR 'NO', OR A RATING SCALE (E.G. FROM STRONGLY AGREE TO STRONGLY DISAGREE).

- **CLOSED-ENDED QUESTIONS** ARE NARROW IN FOCUS AND USUALLY ANSWERED WITH A SINGLE WORD OR A PICK FROM LIMITED MULTIPLE-CHOICE OPTIONS (E.G. "ARE YOU SATISFIED WITH THIS PRODUCT?" → *YES/NO/MOSTLY/NOT QUITE*).

- THEY ARE USED TO OBTAIN FACTS AND SPECIFIC PIECES OF INFORMATION.

- THEY DO NOT INVITE OR ENCOURAGE PEOPLE TO ELABORATE.

Closed Ended vs Open Ended

- STANDARDIZE RESPONSES. MEMORY-BASED RESPONSES.
- IN CAREFULLY-WRITTEN CLOSED QUESTIONS, THE QUESTION AND RESPONSES MEAN THE SAME THING TO NEARLY ALL RESPONDENTS.
- FASTER TO ADMINISTER.
- EASIER AND FASTER TO MARK.
- AVOID QUESTIONS THAT HAVE THE FOLLOWING CHARACTERISTICS:
  - ANSWERS THAT PROVIDE FACTS
  - EASY TO ANSWER QUESTIONS
  - ANSWERS THAT CAN BE GIVEN QUICKLY AND REQUIRE LITTLE TO NO THOUGHT.

Closed Ended vs Open Ended

- OPEN-ENDED QUESTIONS ARE QUESTIONS THAT CANNOT BE ANSWERED WITH A SIMPLE ‘YES’ OR ‘NO’, AND INSTEAD REQUIRE THE RESPONDENT TO ELABORATE ON THEIR POINTS.

- **OPEN-ENDED QUESTIONS** START WITH “WHY?,” “HOW?,” AND “WHAT IF?”

- THEY REQUIRE A PERSON TO PAUSE, THINK, AND REFLECT.

- ANSWERS, TYPICALLY, WILL NOT BE FACTS, BUT PERSONAL FEELINGS, OPINIONS, OR IDEAS ABOUT A SUBJECT

- **OPEN-ENDED QUESTIONS** ARE BROAD AND CAN BE ANSWERED IN DETAIL (E.G. "WHAT DO YOU THINK ABOUT THIS PRODUCT?"),

- AN OPEN-ENDED QUESTION IS DESIGNED TO ENCOURAGE A FULL, MEANINGFUL AND DELIBERATE ANSWER USING THE SUBJECT'S OWN KNOWLEDGE AND/OR FEELINGS.

- ASK OPEN-ENDED QUESTIONS WHEN YOU WANT DETAILED EXPLANATIONS.

- OPEN QUESTIONS ENABLE RESPONDENTS TO ANSWER AS THEY WISH.

Example of closed-ended questions	Modified to open-ended questions
Which of the following numbers are prime? 7, 57, 67, 117	*Fred thinks that 57 and 67 are prime because they both end in 7, which is a prime number. Dick says he is wrong. Who is correct and why?*
What are the next three numbers in the following sequence? 1, 4, 7, 10, 13, ___, ____, ____	*Consider the following sequence: 1, 4, 7, 10, 13, ... Is 100 a member of this sequence? Explain your reasoning.*
Round 37.67 to the nearest 10th.	*Generate three different numbers that when rounded to the nearest 10th give 37.7.*
Find the LCM of 18 and 24	*Why can't 48 be the LCM of 18 and 24?*

FEATURES OF OPEN-ENDED QUESTIONS

COONEY ET AL (2004) STIPULATES THAT OPEN-ENDED QUESTIONS SHOULD

EXHIBIT THE FOLLOWING FEATURES:

1. IT INVOLVES A **SIGNIFICANT CONCEPT** IN A RELATED FIELD. GIVE STUDENTS THE CHANCE TO DISPLAY THEIR UNDERSTANDING BY LINKING THE ENTIRE TOPIC AND HOW IT CAN LEAD TO REAL WORLD PROBLEM SOLVING.
2. THERE COULD BE **MULTIPLE ANSWERS** TO OPEN-ENDED QUESTIONS. WHEN A QUESTION REQUIRES ONE CORRECT ANSWER, STUDENTS OFTEN CONCLUDE THERE IS ONLY ONE WAY TO SOLVE THE PROBLEM. QUESTIONS THAT REQUIRE STUDENTS TO EXPLAIN THEIR THINKING WILL ENCOURAGE A VARIETY OF RESPONSES OR REACTIONS BECAUSE NOT ALL STUDENTS THINK THE SAME.
3. NEED TO **COMMUNICATE THE REASONING** PROCESS. ONE STRONG POINT OF USING OPEN-ENDED QUESTIONS IS THAT STUDENTS ARE GIVEN THE OPPORTUNITY TO COMMUNICATE WHAT IS IN THEIR MINDS.

4. OPEN-ENDED QUESTIONS SHOULD BE CLEARLY STATED.

THESE TYPES OF QUESTIONS SHOULD HAVE A CLEAR PURPOSE EVEN IF THERE ARE MANY DIFFERENT ANSWERS. IN ADDITION, STUDENTS NEED TO KNOW WHAT IS EXPECTED OF THEM AND WHAT LECTURERS CONSIDER AS A GOOD AND COMPLETE RESPONSE.

TEMPLATES

HTTPS://WWW.GREENEESC.ORG/DOWNLOADS/FILE_278_2_238.PDF

- WHY DO_____? EXPLAIN YOUR ANSWER.
- WHAT ARE SOME POSSIBLE EXPLANATIONS AS TO WHY_____?
- WOULD OTHER _____BE AFFECTED BY _____? WHY OR WHY NOT?
- HOW DOES _____? SUPPORT YOUR ANSWER (WITH INFORMATION FROM READING, FROM THE CHART ETC.).
- TELL WHAT _____DID WRONG. HOW WOULD YOU DESIGN A BETTER WAY?
- EXPLAIN HOW YOU ARRIVED AT YOUR ANSWER USING PICTURES, WORDS, EQUATIONS. (MATH)
- PREDICT AND DESCRIBE _____. SUPPORT AND DEFEND YOUR ANSWER.
- DISCUSS THE LIKELIHOOD THAT _____
- FROM THE INFORMATION ON CHART, WHAT IS TRUE OF _____?

- SUPPOSE YOU WANT TO _____. MAKE A _____ AND _____. TELL WHY YOU CHOSE (INCLUDED) EACH.

- IF YOU HAD TO _____, WHICH _____WOULD YOU SUGGEST. EXPLAIN YOUR ANSWER.
- MAKE A GRAPH SHOWING _____. (MATH)

- WOULD YOU RATHER HAVE _____ OR _____? TELL WHY. (MATH)

- WHAT COULD BE DONE ABOUT _____? GIVE REASONS FOR YOUR ANSWER
- COMPARE THE _____. TELL WHICH _____WOULD BE MOST LIKELY AND WHICH _____WOULD BE LEAST LIKELY. SUPPORT YOUR ANSWER.

CHALLENGES

- UNDERSTANDING OF OPEN-ENDED QUESTIONS
- LIMITATIONS ON EXISTING COURSE LEARNING OUTCOMES THAT ARE OF LOW LEVEL BLOOM TAXONOMY
- GREATER EFFORT OF CONSTRUCTING OPEN-ENDED QUESTIONS
- LENGTHIER TIME FOR MARKINGS
- STUDENTS LIMITED UNDERSTANDING ON REQUIREMENTS OF OPEN-ENDED QUESTIONS

EXAMPLE 1

a) *Determine the optimum solutions at the end user level for improving overall voltage sag performance and reliability.*

b) *Design a simple test distribution system for the customer facility as shown in Figure 2. PCC-1 is the utility bus at 13.8 kV and PCC-2 is the customer bus at 480 V. The data of PCC-2 bus are as follows:*

$Tr_2 = 1000\ kVA$, *5.0% impedance on 1000 kVA base*

$I_{load} = 1000\ A$

The measured distortion is equal to 90 A at 5^{th} *harmonic and 44 A at* 7^{th} *harmonic. The short circuit impedance on 13.8 kV bus is equal to 1.7% on 1000 kVA base.*

EXAMPLE 2

Q1 (a) Given the rotational mechanical system of Figure 1, where damper, $D = 1$ and $T(t)$ is a unit step.

Calculate the values of J and K to yield a response of 30% overshoot and a settling time of 4 seconds.

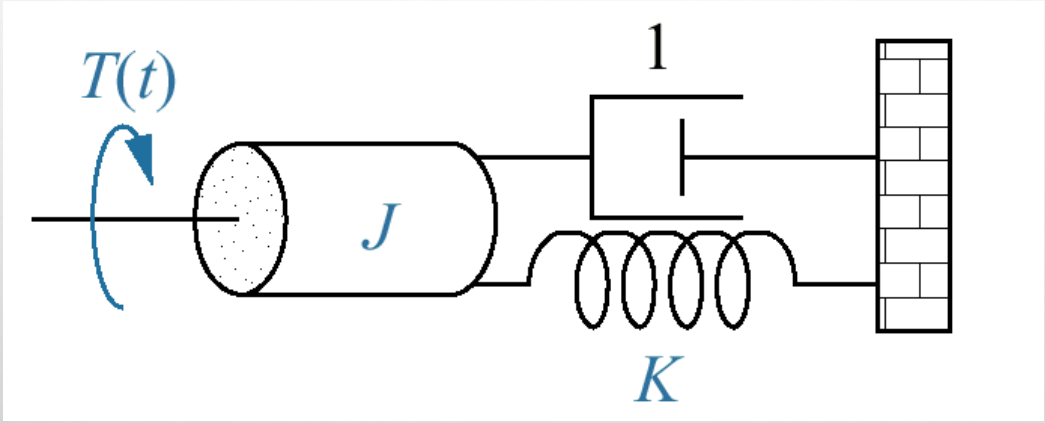


Figure 1: Rotational mechanical system.

(9 marks)

Example 3

A material is needed for the construction of a robotic arm for industrial application. The material to be chosen is the one that shows the smallest amount of elastic deformation.

i. Suggest TWO (2) mechanical properties that must have for the chosen materials.

(2 marks)

ii. Justify your answer in (i).

(4 marks)

EXAMPLE 4

Bicycle (bike) come in many forms, each aimed at a particular sector of the market. Consider a design of sprint bikes and a Children's bikes.

i. Identify TWO (2) constraints that must be met for each of the bicycle frame.

(2 marks)

ii. Justify each of the identified constraints in (i).

(4 marks)

iii. Suggest the primary objective of the sprint bikes frame and the children's bike frame.

(2 marks)

iv. Justify your answer in (iii).

(4 marks)

EXAMPLE 5

The world today is continuously striving towards carbon neutral clean energy technology. Hence, renewable energy sources like wind power system is increasingly receiving the attention of mankind. Your company is planning to produce a wind turbine electricity generators blades. The blade size should be of 20 to 60 m in length, with complex aerofoil contours, minimum weight, very low maintenance, operated outdoor (expose to sun, rain, hail, storms, heat, cold dust, impact) with expected life time of more than 20 years.

i. Propose the most suitable material for the wind turbine blade.

[Note: Show the materials index performance and design requirement in your answer. Your evaluated candidates should include at least three materials. Appendix I is provided as guidance only, but not limited to.]

(12 marks)

ii. Describe type of construction that you will adopt to produce the blades.

(7 marks)

iii. Sketch the blades design that you will use in (ii).

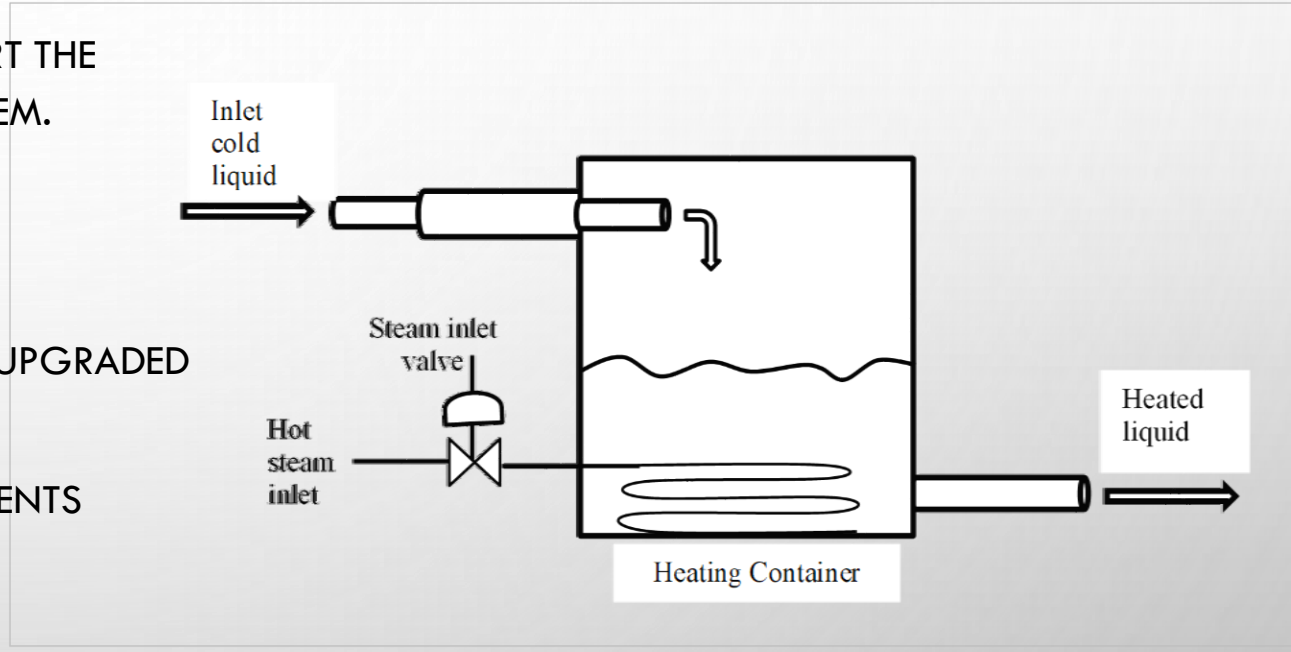
(4 marks)

EXAMPLE 6

FIGURE 1 SHOWS AN EXAMPLE OF A HEATING PROCESS CONTROL APPLIED IN THE INDUSTRY. THE INLET COLD LIQUID STREAM IS TO BE HEATED TO CERTAIN TEMPERATURE BEFORE DISCHARGES TO THE NEXT PROCESS. A HOT STEAM INLET PROVIDES THE HEATING REQUIRED.

SUGGEST IMPROVEMENTS TO THE SYSTEM THAT WOULD CONVERT THE CURRENT HEATING PROCESS INTO CLOSED LOOP CONTROL SYSTEM.

- NOTE:
- CONSTRUCT THE OPEN LOOP BLOCK DIAGRAM.
- CONSTRUCT THE CLOSED LOOP BLOCK DIAGRAM OF THE UPGRADED SYSTEM
- RE-SKETCH THE FIGURE AND HIGHLIGHT ADDITIONAL ELEMENTS ADDED.
- (10 MARKS)



II. DISCUSS IN TERM OF FUNCTIONALITY OF THE IMPROVED SYSTEM TO MAINTAIN ITS CONTROL PERFORMANCE IN ENVIRONMENT WHERE THE UPGRADED SYSTEM IS EXPOSED TO VARYING SURROUNDING WEATHER CONDITIONS (ADDITIONAL HEAT AND COOLING FROM THE ENVIRONMENT).

Example 7

Q4 Figure 5 shows block diagram of a control system. It represents position control of a CNC milling machine positioning table. A position controller, $G_c(s)$ is to be design fulfilling the following performance criteria:

i. A percentage overshoot of just 5% for a step input.

ii. An improvement of 50% from the current system settling time.

In complex plane, the dominant second order pair of poles for the uncompensated system is located at -3.35 + 3.51j while in frequency domain, the static error constant must equals 40 to meet the steady-state error requirement.

(a) Solve for the gain K that would meet the respective system requirement.

(4 marks)

(b) Design a position controller, $G_c(s)$ that meets the system response requirements using **either a Root Locus method or** a **Frequency Response method**.

[Note: The open loop Bode diagram of the system is shown in Figure 6]

(12 marks)

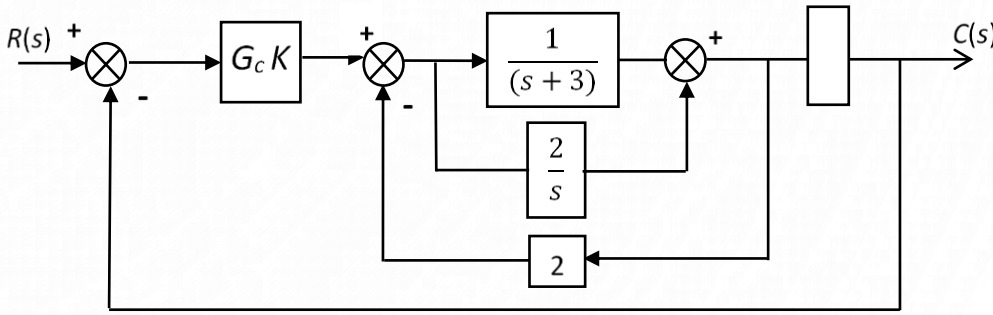


Figure 5: Block diagram of a control system with gain K

Example 8

Q1 (a) Given $f(x,y) = 5x^3 + 2xy - 3x^2\cos(y) + 8$:

i. Classify whether $f_{xy} = f_{yx}$ or otherwise.

(5 marks)

ii. Calculate $f_{xy}(5,2\pi)$ and $f_{yx}(5,2\pi)$ using a result in (i).

(2 marks)

(b) Consider one of the critical points for the function, $f(x,y) = 2xy + \frac{1}{x} + \frac{4}{y}$ is $(\frac{1}{2},2)$.

i. Differentiate f_x, f_y, f_{xx}, f_{yy} and f_{xy}.

(9 marks)

ii. Compute a value of $f_{xx}(\frac{1}{2},2)$, $f_{yy}(\frac{1}{2},2)$ and $f_{xy}(\frac{1}{2},2)$.

(5 marks)

Example 9

Q2 Manufacturing engineer works to locate a center of gravity as a drilled hole location of a thin composite plate with a density is constant. Figure 1 shows the shape of a plate consists of a semicircle with a radius of 10 cm and a square.

(a) Compute an area of the plate using double integral.

(b) Construct a center of gravity using double integral.

(c) Determine M_y if the density of a plate is 0.5 gcm^{-3}.

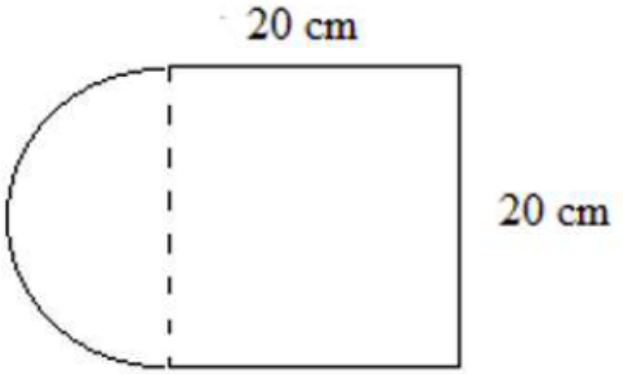


Figure 1: Composite plate

Example 10

- ✓ PICK AND APPLICATION IN MANUFACTURING WHEREBY A SPECIFIC TASK (PICK-AND-PLACE, ASSEMBLY, POLISHING, WELDING ETC.) IS BEING HANDLED BY A ROBOTIC SYSTEM.
- ✓ SELECT THE BEST ROBOT CONFIGURATION (CARTESIAN, CYLINDRICAL, SPHERICAL, ARTICULATE) FOR THE TASK SELECTED.
- ✓ SELECT FROM LITERATURE (NOT TEXTBOOK), AN INDUSTRIAL-APPLY ROBOT MANIPULATOR SUITABLE FOR THE TASK AND CONFIGURATION SELECTED.
- ✓ CONSTRUCT THE D-H REPRESENTATIVE FOR THE ROBOT MANIPULATOR SELECTED (INDICATE/ASSIGN ALL DIMENSIONS AS NECESSARY WITH PROPER LABELING).
- ✓ PERFORM D-H ANALYSIS BY CONSTRUCTING THE DH PARAMETER TABLE.
- ✓ SOLVE FOR THE OVERALL TRANSFORMATION MATRIX OF THE ROBOT STRUCTURE (USE ANY AVAILABLE NUMERICAL SOFTWARE TO ASSIST YOU) BY ASSIGNING NUMERICAL VALUES TO ALL RESPECTIVE ANGLES.