



**THE UNIVERSITY OF ZAMBIA**  
**SCHOOL OF ENGINEERING**

**MEC3102 PRODUCTION ENGINEERING I, ELECTRICITY &  
ELECTRONICS II**

**2021/2022 ACADEMIC YEAR, TERM II**

**TERM EXAM (SUPPLEMENTARY)**

**TIME: THREE HOURS.**

**CLOSED BOOK**

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**INSTRUCTIONS**

1. Answer a total of FIVE (5) Questions.
  2. **This** Question paper has **Seven Questions (7)**. Answer not more than Three (3) Questions from **SECTION A** and not more than **Two (2) Questions from SECTION B**.
  3. **All** Questions carry **Equal Marks**, that is, **20 Marks** per Question.
  4. This Exam has **Seven (7) pages** including this cover.
  5. No external Materials are Allowed in the Exam.
  6. The Answer scripts should be bound/stapled separately, i.e., **SECTION A** and **SECTION B** separately.
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## SECTION A

### QUESTION 1

(a) Briefly describe the following three common machining processes.

- (i) Turning, [1 marks]
- (ii) Drilling, [1 marks]
- (iii) Milling. [1 marks]

(b) The two basic categories of cutting tools in machining are single-point tools and multiple-edged cutting tools as shown in Fig. Q1 b (i) and (ii). Give an example(s) of a machining operation that uses each of the tooling types. [2 marks]

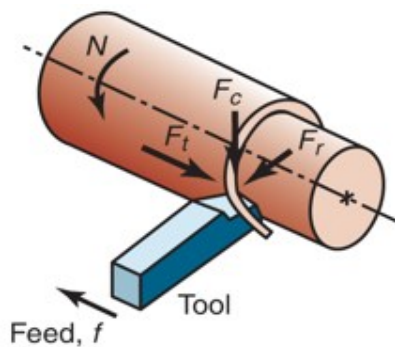


Fig. Q1 b(i)

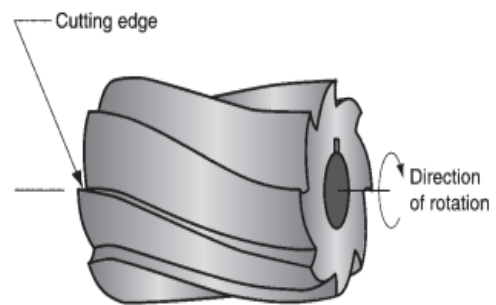


Fig. Q1 b(ii)

- (i) List down the parameters  $N$ ,  $F_c$ ,  $F_t$ ,  $F_r$ , indicated in Qb (i) and give specific examples where this single-point tools are used. [2 marks]
  - (ii) Briefly describe how multiple-cutting-edge tools achieve their cutting operation and give typical examples of where these tools are used. [2 marks]
  - (iii) Identify the parameters of a machining operation that are included within the scope of cutting conditions. [3 marks]
- (c) A drilling operation is to be performed with a 25.4 mm diameter twist drill in a steel work part. The hole is a blind-hole at a depth = 50 mm, and the point angle =  $118^\circ$ . Cutting conditions are speed = 25 m/min, feed = 0.25 mm/rev.

Determine:

- (i) The cutting time to complete the drilling operation, [4 marks]
- (ii) Metal removal rate during the operation, after the drill bit reaches full diameter.

[4 marks]

## QUESTION 2

A series of turning tests are performed to determine the parameters  $n$ ,  $m$ , and  $K$  in the expanded version of the Taylor equation. The following data were obtained during the tests: (1)  $v = 2.0$  m/s,  $f = 0.20$  mm/rev,  $T = 12$  min; (2)  $v = 1.5$  m/s,  $f = 0.20$  mm/rev,  $T = 40$  min; and (3)  $v = 2.0$  m/s,  $f = 0.3$  mm/rev,  $T = 10$  min.

- (a) Determine  $n$ ,  $m$ , and  $K$ . [10 marks]
- (b) Using your equation, compute the tool life when  $v = 1.5$  m/s and  $f = 0.3$  mm/rev. [10 marks]

## QUESTION 3

The following data were obtained from a cutting test:  $\gamma = 20^\circ$ ,  $k = 90$ , depth of cut 6.4 mm, feed 0.25 mm/rev, chip length before cutting 29.4 mm, chip length after cutting 12.9 mm. The cutting forces were axial force 427 N, vertical force 1050 N.

Use Merchant's analysis to calculate:

- (a) The direction and magnitude of the resultant force. [5 marks]
- (b) The shear plane angle. [5 marks]
- (c) The frictional force. [5 marks]
- (d) The friction angle. [5 marks]

## QUESTION 4

- (a) (i) What is metrology? [2 marks]
- (ii) Certain geometric quantities have been defined over the years. One such system is the International Organization for Standardization (ISO) system, shown in Fig. Q4 (ii). Note that both the shaft and the hole have minimum and maximum diameters, the difference being the tolerance for each member. What is the difference between bilateral and unilateral tolerance? [6 marks]

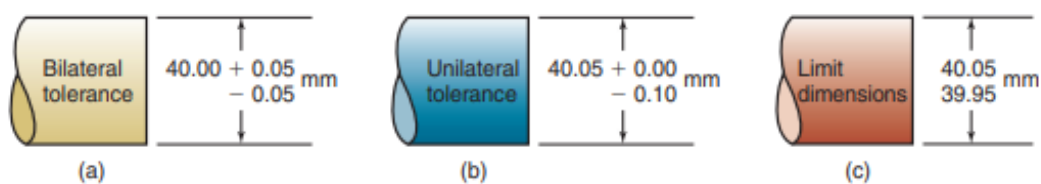


Fig. Q4(ii)

(b) The most commonly used quantities and geometric features in engineering practice are listed below. Briefly describe the features for each of the following quantities

- (i) Length, **[2 marks]**
- (ii) Diameter, **[2 marks]**
- (iii) Roundness, **[2 marks]**
- (iv) Parallelism, **[3 marks]**
- (v) Perpendicularity **[3 marks]**

## SECTION B

### QUESTION 5

- 5.1** What are Magnetic fields and give two examples where they are applied in electrical energy conversion. **[4 marks]**
- 5.2** A shunt generator supplies a 50-kW load at 400 V through cables of resistance  $0.2 \Omega$ . If the field winding resistance is  $50 \Omega$  and the armature resistance is  $0.05 \Omega$ , determine
- i. The terminal voltage,
  - ii. The e.m.f. generated in the armature. **[2 + 2 marks]**
- 5.3** Find the value of  $I$  required to establish a magnetic flux of  $\Phi = 0.75 \times 10^{-4} \text{ Wb}$  in the series magnetic circuit shown in fig. 5.3.1. Make use of the B-H curve (5.3.2) to determine the magnetic flux intensity of cast steel. **[12 marks]**

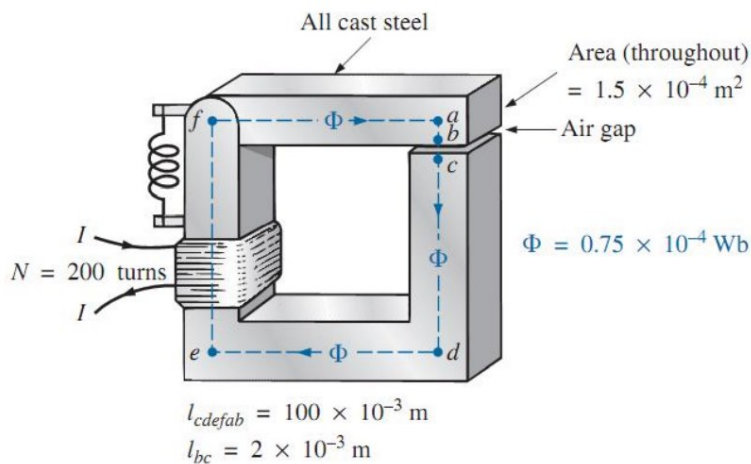


Fig. 5.3.1

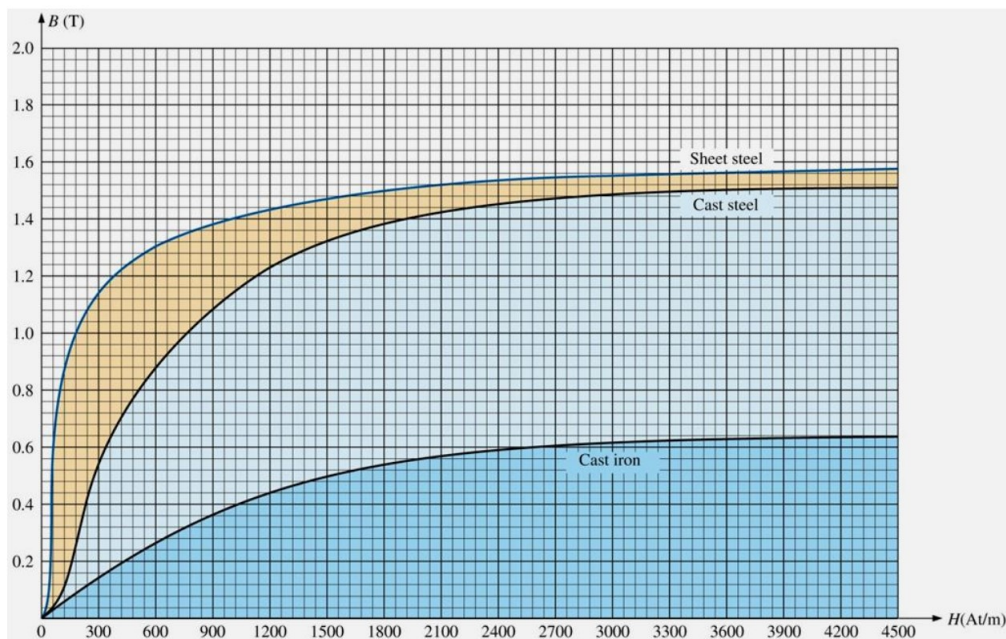


Fig. 5.3.2. B-H curve for Q5 (5.3)

**Total Marks [20]**

## QUESTION 6

- 6.1 Define power system. [2 marks]
- 6.2 Name any four (4) factors you need to consider before choosing the appropriate electric power generation method. [4 marks]
- 6.3 A three-phase delta-connected load, each phase of which has an inductive reactance of  $40 \Omega$  and a resistance of  $25 \Omega$ , is fed from the secondary of a three-phase star-connected transformer which has a phase voltage of  $230 \text{ V}$ . Draw the circuit diagram of the system and calculate:
- The current in each phase of the load; [3 marks]
  - The p.d. across each phase of the load; [2 marks]
  - The current in the transformer secondary windings; [2 marks]
  - The total active power taken from the supply and its power factor. [3 marks]
- 6.4 Two Wattmeters are used for measuring the power input and the power factor of an over-excited synchronous motor. If the readings on the meters are ( $7.0 \text{ kW}$ ) and ( $2.0 \text{ kW}$ ) respectively. Calculate the input power and power factor of the motor.

[1 + 3 marks]

**Total Marks [20]**

## QUESTION 7

- 7.1 An electric light is to be controlled by three switches. The light is to be **ON** whenever switches  $A$  and  $B$  are in the same position; when  $A$  and  $B$  are in different positions, the light is to be controlled by switch  $C$ .
- Draw up a truth table for this situation. [2 marks]
  - Represent the light function  $Y$  in terms of  $A$ ,  $B$  and  $C$ . [2 marks]
  - Simplify the function using the Karnaugh map, hence **design** the practical switching circuit using logic gates. [5 marks]
- 7.2 Using  $A \oplus B = \overline{A}B + A\overline{B}$ , write the expression for  $f$  in fig. 7.2 and simplify the expression obtained using Boolean algebra. [5 marks]

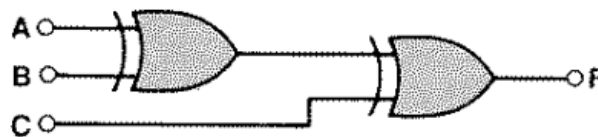


Fig. 7.2

- 7.3 Explain the principle behind the numbering of columns and rows in a Karnaugh map. [1 mark]
- 7.4 The sum-of-products Boolean expression in short form notation is given by

$$f(A, B, C) = \sum 3, 5, 6, 7$$

- Draw the Minterm Karnaugh map for the given expression. [3 marks]

- ii. Using the Karnaugh map in (i) find the minimized Boolean expression.

[2 marks]

**Total Marks [20]**

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**END OF MEC 3102 SUPPLEMENTARY EXAMINATION**

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