Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2019/2020

COURSE NAME	:	SUPERCONDUCTOR
COURSE CODE	:	BWC 40203
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2019 / JANUARY 2020
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 (a) Derive London first and second equation. (***Hint**: use Newton second law of motion and Maxwell equation)*

(10 marks)

(b) Using a specific Maxwell's equation, prove that a cooled superconductor (superconducting in zero magnetic field) does not behave like an ideal conductors.
(**Hint**: $\chi = -1$: perfect diamagnetism)

(6 marks)

(c) A Type I superconductor has a critical temperature of 10 K in zero magnetic field and a critical field of 0.2 Tesla at 0 K. Compute the critical field, B_C at 5K.

(4 marks)

Q2 (a) Give a brief description for the following terms and definations.

(i) Superconductors.

(2 marks)

(ii) Superconductivity.

(2 marks)

(iii) Perfect diamagnetism.

(2 marks)

(iv) Critical temperature.

(2 marks)

(b) Differentiate between Type I and Type II superconductors by drawing the curve of magnetization versus external magnetic field. Give **ONE (1)** example of Type I and Type II superconductors.

(6 marks)

(c) Using appropriate diagram, explain in detail Meissner effect phenomena.

(6 marks)

Q3 (a) In 1935, Fritz and Heinz London proposed London theory which include London first and second equation. Distinguish between these two equations.

(4 marks)

(b) Differentiate the term of metal-insulator-metal (NIN), metal-insulator-superconductor (NIS) and superconductor-insulator-superconductor (SIS). Sketch the *I-V* diagram for each.

(6 marks)

(c) Differentiate the theory introduced by "London" and "Ginzburg-Landau". (4 marks)

(d) Using appropriate diagram, describe the Bardeen-Cooper-Schrieffer (BCS) theory. (6 marks)

Q4 (a) Define the term of superconducting quantum interference device (SQUID). Give several application of SQUID. (4 marks)

(b) Sketch the *I-V* diagram for AC and DC Josephson effect. Discuss the different between AC and DC Josephson effect. (6 marks)

(c) Describe in detail the following application:

(i) Magnets for magnetically levitated trains, MAGLEV. (5 marks)

(ii) Superconducting magnetic energy storage system, SMES. (5 marks)

Q5 Using suitable sample preparation method, propose and explain in detail the flow chart for synthesization of high temperature superconductivity of $DyBa_{2-x}Sr_xCu_3O_7$. (20 marks)

– END OF QUESTIONS –

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LIST OF FORMULA

$$\Phi = n\left(\frac{h}{2e}\right) \qquad \Phi_0 = \frac{h}{2e}$$

$$E_g(0) = 3.53 k_B T_C \qquad B = \mu_0 H$$

$$\lambda^2 = \frac{m}{\mu_0 n_s e^2} \qquad H = \frac{M}{\chi}$$

$$\Phi = n\Phi_0 \qquad B_i = B_a + \mu_0 M$$

$$\nu = \frac{2Ve}{h} \qquad B_C = B_c(0)\left[1 - \left(\frac{T}{T_c}\right)^2\right]$$

$$\lambda = \lambda(0)\left[1 - \left(\frac{T}{T_c}\right)^4\right]^{-1/2} \qquad J_C = J_c(0)\left[1 - \left(\frac{T}{T_c}\right)^2\right]\left[1 - \left(\frac{T}{T_c}\right)^4\right]^{1/2}$$