Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2016/2017

COURSE NAME	:	SUPERCONDUCTOR
COURSE CODE	:	BWC 40203
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	DECEMBER 2016 / JANUARY 2017
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

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

Q1 (a) Each term given in the list below refers to some superconductors concepts and properties. Distinguish between each pair of terms by reffering to their definitions.

(i) Critical field and critical temperature.
(ii) Perfect conductor and perfect diamagnetism.

(8 marks)

(b) Distinguish between superconductors and normal conductor using appropriate diagram.

(6 marks)

(c) The transition temperature, T_c of a superconductor is inversely proportional to the power of mass ions of the lattice, M^{α}

$$T_C \propto \frac{1}{M^{\alpha}}$$

For mercury, $\alpha = 0.50$. Calculate the transition temperature for sample of ^{201}Hg, ^{202}Hg and ^{204}Hg, if the transition temperature for ordinary mercury is 4.143 K for an average atomic mass of 200.59 u.

(6 marks)

Q2 (a) Describe the flux quantization in superconducting using suitable diagram. Write the equation of flux quantization.

(8 marks)

(b) A voltage of 5.0 μV is applied across a Josephson junction. Determine the frequency of the radiation emitted by the junction.

(6 marks)

(c) With the aid of diagram(s), explain the differences between AC and DC Josephson effect.

(6 marks)

Q3 (a) Briefly explain the phenomena of Meissner effect using appropriate diagram.

(6 marks)

(b) A Type I superconductor has a critical field $B_c = 0.3$ T and a critical current density $J_c = 2 \times 10^4$ A/cm^2 at 0 K. Calculate B_c, J_c and λ at $T = 1/2T_c$.

(6 marks)

(c) Sketch the magnetization versus external magnetic field for Type I and Type II superconductors. Compare the differences between Type I and Type II superconductors.

(8 marks)

Q4 (a) The actual energy gap at 0 K in lead is 2.7×10^{-3} eV.

(i) What is the prediction of the BCS theory for this energy gap.
(ii) Determine the minimum frequency of radiation which could break apart Cooper pairs in lead at 0 K.

(10 marks)

(b) Relate the following application with the theory of superconductor:

(i) Magnets for magnetically levitated trains, MAGLEV
(ii) Superconducting magnetic energy storage system, SMES

(10 marks)

Q5 Propose **ONE (1)** method to prepare the high temperature superconductor (HTSC) of $TlBa_2CaCu_2O_7$ (Tl1212) and constuct a flow chart based on the preparation technique used.

(20 marks)

– END OF QUESTIONS –

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LIST OF FORMULA

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

$$\Phi_0 = \frac{h}{2e}$$

$$E_g(0) = 3.53 k_B T_C$$

$$B = \mu_0 H$$

$$\lambda^2 = \frac{m}{\mu_0 n_s e^2}$$

$$H = \frac{M}{\chi}$$

$$\Phi = n\Phi_0$$

$$B_i = B_a + \mu_0 M$$

$$\nu = \frac{2Ve}{h}$$

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

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

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