Ref No Ex/PG/METIM-MATE/T/114A/23, 25/2017

M. Tech. Mat. Engg. and M. Met. Engg. (I.M.) 1st Sem. Examination, 2017

Subject: Characterisation of Materials

Time: 3 hours **Full Marks: 100**

Question number 1 is compulsory. Answer any two (2) questions from the rest. Answers must be brief and to the point. All parts of the same question must be answered contiguously.

One (1) mark for neatness

1 **Answer any seven (7) questions.** 7x7

(a) Which technique(s) can be used for determination of phase diagram? Substantiate.

(b) In a light microscope an object is placed 2 mm away from a lens of diameter 2 mm. The object is in air (refractive index: 1). The wave length of the light (green) is 520 nm. What is the best possible resolving power of this microscope?

(c) Calculate the depth of field for a resolving power of 1 micron in a microscope with a final aperture of diameter 1 mm and a working distance of 20 mm.

(d) If lenses with maximum useful magnification of 40X are available, how many lenses are needed to achieve magnifications of 100X, 10000X and 1 million X?

(e) A specimen of 0.3 wt % of plain carbon steel was heated to 1000 °C for 1 hour. Then the specimen was cooled in water. What technique(s) will you recommend to identify the phase transformations? Justify.

(f) A scanning electron microscope is operated at 20 kV. Determine the wave length of the electron beam. Electron mass=9.1×10^{-31} kg; Electron charge= 1.6×10^{-19} Coulomb; Planck's constant=6.6×10^{-34} J s

(g) In powder diffraction of Copper (lattice parameter: 0.361 nm) taken with Copper Kα radiation (λ=0.154 nm) what will be the Bragg angle for the first diffraction peak?

(h) Describe the principle of determination of grain boundary misorientation angles.

2 (a) Describe the method(s) of generating a TTT diagram in 0.4 wt% plain carbon steel. 8

(b) What is Ewald sphere? Describe significance of Ewald sphere construction. 7

(c) You are asked to do x ray diffraction of austenitic stainless steel (lattice parameter 0.359 nm) using Cu K_α radiation (λ=0.154 nm). Derive which atomic planes will participate in reflection. Recommend the range of angle in which you will conduct the x ray diffraction experiment. 10

3 (a) Describe the principles of formation of bright field and dark field images in TEM. Prove that the distance R between the transmitted beam, and the diffracted beam, as measured on an electron diffraction pattern obtained using a transmission electron microscope is proportional to the reciprocal of the spacing d of planes giving rise to the diffracted beam. 8+9

(b) Differentiate: Secondary electron and Back scattered electron in SEM. 8

4. (a) Describe the experimental method(s) to determine whether a chemical reaction is exothermic or endothermic. 7

(b) What are the possible sources of error while measuring lattice parameter using x ray? How do you optimize accuracy in lattice parameter measurement? 10

(c) Compare and contrast: continuous spectrum and characteristic spectrum 8