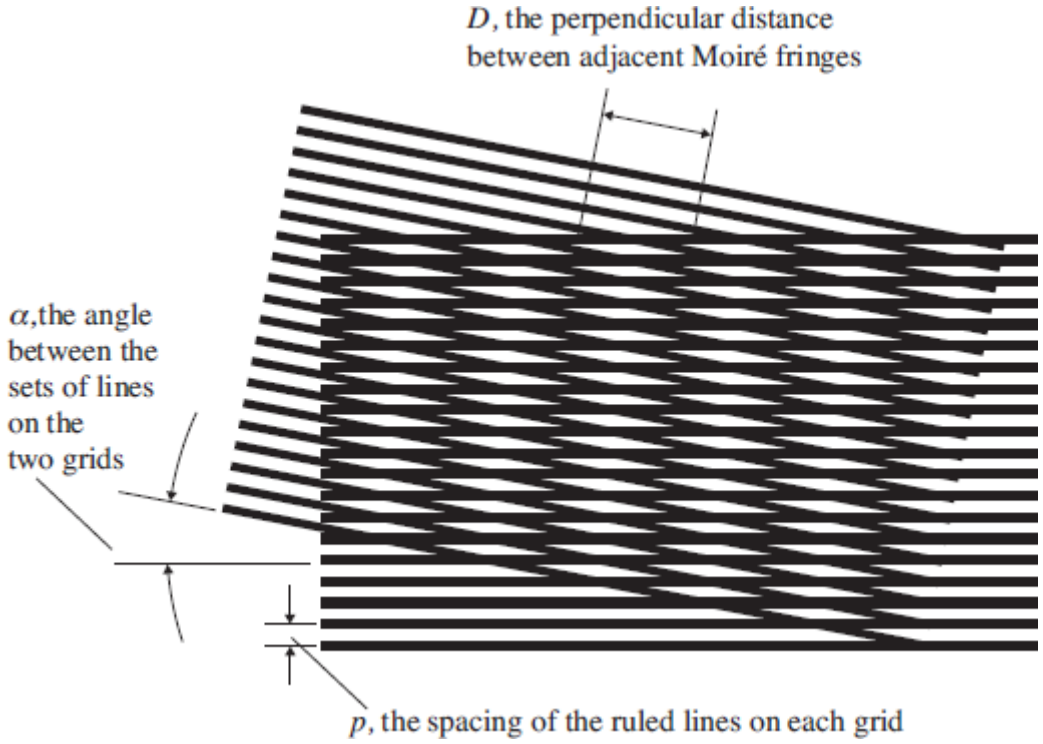
Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Q1.

Two grids of parallel ruled lines can be used to produce Moiré fringe patterns, as shown below.



A student obtains two diffraction gratings thought to be identical with a line spacing of about 3×10^{-6} m. The student finds that when these are placed together and viewed against a white background a Moiré fringe pattern is observed when one grating is rotated slightly. For small angles, the distance between the Moiré interference fringes, D, is given by the approximate equation, $D \simeq \frac{57p}{\alpha}$, where α is in degrees.
By assuming that $p = 3.0 \times 10^{-6}$ m, the student uses this equation in a spreadsheet to find D for values of α up to 16°.

The student's results are shown below.

α / °	D / mm
2	0.0855
4	0.0428
6	0.0285
8	0.0214
10	0.0171
12	0.0143

14	0.0122
16	0.0107

The student intends to view the Moiré fringes through a microscope to check the spreadsheet results for D by measuring D using the microscope directly.
The vernier scale on the microscope can measure to the nearest 0.01 mm.

(a) Explain using suitable calculations why this microscope is not suitable to check the results of the spreadsheet calculation.

(4)

(b) The equation for D can be rearranged to give $p \simeq \frac{\alpha D}{57}$.

The student suggests that if a better microscope can be provided and α can be set to produce values of D greater than 0.10 mm, the value of p can be found experimentally. Discuss whether the student's suggestion is sensible.

(2)

(c) The theoretical separation of the Moiré fringes when α = 2°, shows D = 0.0859 mm. Calculate the percentage difference between this value and the student's spreadsheet result for D when α = 2°.

(2)

(Total 8 marks)

Q2.

(a) Draw a ray diagram for an astronomical refracting telescope in normal adjustment. Your diagram should show the paths of **three** non-axial rays through both lenses. Label the principal foci of the two lenses.

(3)

(b) An early form of this telescope was built by Johannes Hevelius. It was 3.7 m long and had an angular magnification of 50. Hevelius used it to help produce one of the earliest maps of the Moon's surface.

(i) Calculate the focal lengths of the objective lens and eyepiece lens in an astronomical telescope of length 3.7 m and angular magnification 50.

focal length of objective lens = _____ m

focal length of eyepiece lens = _____ m

(2)

(ii) The Triesnecker Crater on the Moon has a diameter of 23 km. Calculate the angle subtended by the image of this crater when viewed through a telescope of angular magnification 50 on the Earth.

distance from Earth to Moon = 3.8×10^5 km

angle = _____ rad

(2)

(c) Early refracting telescopes suffered significantly from chromatic aberration. Draw a diagram to show how a single converging lens produces chromatic aberration.

(2)
(Total 9 marks)