Course and assignment number:

Computer Marked Assignment

S357 43

Make sure you know how to use the CMA form: detailed instructions are given in your student handbook (or supplement).
You are strongly advised to attempt every question in this assignment.
If you do not wish to answer a question, pencil across the 'don't know' cell ('?').
If you think that a question is unsound in any way, pencil across the 'unsound' cell ('U') *in addition to* pencilling across either an answer cell or the 'don't know' cell.
Note For each question you **must** *pencil across* **either** *the required number of answer cells* **or** *the 'don't know' cell.*

Covering: **Units 10–12**

Cut-off date:
Friday 15 August 1997

AX BV CX
DV EX FX

Q1 A curve $\mathscr{C}$ is defined by the (Cartesian) coordinate functions $x^1(\tau) = 7\tau^2$; $x^2(\tau) = -3\tau + 2\tau_0$ where τ_0 is a positive constant. Which one of the items in the key correctly describes the length measured along the curve from the point $(x^1, x^2) = (0, 2\tau_0)$ to the point $(x^1, x^2) = (28, 2\tau_0 - 6)$? Pencil across *one* cell in row 1.

KEY for Q1

A $\int_0^2 (196\,\tau^2 + 9)^{1/2}\,d\tau$

B $\int_0^1 (49\tau^4 + 9\tau^2 - 12\tau_0\tau + 4\tau_0^2)\,d\tau$

C $\int_0^2 (7\tau^2 - 3\tau + 2\tau_0)\,d\tau$

D $\int_0^1 (7\tau^2 - 3\tau + 2\tau_0)\,d\tau$

E $\int_0^2 (49\tau^4 + 9\tau^2 - 12\tau_0\tau + 4\tau_0^2)\,d\tau$

F $\int_0^1 (196\tau^2 + 9)\,d\tau$

Q2 Which one of the following statements is false? Pencil across *one* cell in row 2.

KEY for Q2

A The ratio of cicumference to diameter for any circle in a plane is always π.

B The metric of the surface of a sphere of radius R may be written

$$\Delta l = \left\{ R^2 \left[(\Delta\theta)^2 + \sin^2\theta\,(\Delta\phi)^2 \right] \right\}^{1/2}$$

C Triangles of different size on the surface of a sphere must differ by more than a simple change of scale.

D The metric of a plane may be written in the form $\Delta l = \left[(\Delta\rho)^2 + \rho\,(\Delta\phi)^2 \right]^{1/2}$.

E A general expression for the metric of a two-dimensional surface is

$$\Delta l = \left[g_{11}\,(\Delta q^1)^2 + g_{12}\,(\Delta q^1 \Delta q^2) + g_{21}\,(\Delta q^1 \Delta q^2) + g_{22}\,(\Delta q^2)^2 \right]^{1/2}$$

Q3 Select the two statements in the key that are true. Pencil across *two* cells in row 3.

KEY for Q3

A If the metric in a given region of spacetime is known, the geodesic equations allow us to predict the world-lines of electrons, protons and other particles in that region.

B If the metric in a given region of spacetime is known, the geodesic equations allow us to predict the world-lines of particles not acted on by any non-gravitational forces in that region.

C In a curved spacetime, test-bodies that experience no non-gravitational forces move along lines of shortest possible length.

D In a plane, there are infinitely many geodesics passing through every point.

E On the surface of a sphere, there are exactly two geodesics through every point.

F On the surface of a sphere, given two different points, there will be infinitely many geodesics linking those two points.

Q4 Which two of the following conditions must be satisfied before the simplified geodesic equations (Equations 38a and 38b) of Unit 10 & 11 can be used to determine a geodesic of the metric of equation 33? Pencil across *two* cells in row 4.

KEY for Q4

A The numerical value of the total length L of the geodesic must be known.

B The metric coefficient g_2 must be chosen in such a way that it is zero at all points on the geodesic, in accord with Equation 38b.

C The quantities q^1 and q^2 must be known functions of the parameter s.

D The quantity L must be a function of the parameter s.

E The metric coefficients g_1 and g_2 must both be known functions of the parameter s.

F The metric coefficient g_1 must be a constant, and g_2 a function of q^1.

F