Registration No: | | | | | | | | | | |

Total Number of Pages: 2 **M.Sc.I**
FPYC804

8th Semester Regular Examination 2017-18
MATHEMATICAL METHODS IN PHYSICS-II
BRANCH: M.Sc.I(AP)
Time: 3 Hours
Max Marks: 70
Q CODE:C307

Answer Part-A which is compulsory and any five from Part-B.
The figures in the right hand margin indicate marks.

Part – A (Answer all the questions)

Q1 **Answer the following questions:** **(2 x 10)**

a) Write the transformation equation for the tensors $A^{\mu\nu}$ and $A_{\mu\nu}$.

b) Express the tensor $A^{\mu\nu}$ as the sum of a symmetric and anti-symmetric tensor.

c) Contract the mixed tensor $A^{\mu\nu}_{\sigma\lambda}$.

d) Write the length element in Riemann space using metric tensor.

e) Write the generating function for Laguerre polynomial.

f) Write the Bessel's differential equation.

g) Define Laguerre Function.

h) Write the Sturm-Liouville Operator and equation.

i) Define Green's function $G(x,\xi)$and explain that it is symmetric with respect to $and\ \xi$.

j) Define a Hermitian operator. What is the nature of its eigenvalues?

Part – B (Answer any five questions)

Q2 **a)** Deduce Fernet's equations for a curve in three-space. **(5)**

b) A covariant tensor has components $xy, 2y - z^2, xz$ in Cartesian coordinates. Find the covariant components in spherical polar coordinates. **(5)**

Q3 **a)** Transform $(ds)^2 = (dx)^2 + (dy)^2 + (dz)^2$ into spherical coordinates using metric tensor. **(5)**

b) Define Christoffel's symbols. Show that $[\mu\nu,\sigma]+[\sigma\nu,\mu]=\frac{\partial g_{\sigma\nu}}{\partial x^{\nu}}$ **(5)**

Q4 **a)** (i)Show that the product $A^{\mu}\ and\ B_{\nu}$ is a mixed tensor of rank two. **(5)**

(ii) Prove that $L^2=g^{\mu\nu}A_{\mu}A_{\nu}$ is an invariant.

b) Prove that $A^{\mu}B_{\mu}\ and\ A_{\mu\nu}B^{\mu}C^{\nu}$ are invariants. **(5)**

Q5 **a)** Starting from the relation $\exp\left[\frac{x(t-\frac{1}{t})}{2}\right]=\sum_{n=-\infty}^{\infty}J_n(x)t^n$, prove that $J_n(x+y)=\sum_{k=-\infty}^{\infty}J_k(x)J_{n-k}(y)$ **(5)**

b) Prove that $J_{m-1}(x)+J_{m+1}(x)=\frac{2m}{x}J_m(x)$ **(5)**

Q6 **a)** Deduce the differential equation satisfied by the Laguerre function. **(5)**

b) Prove that

$$\int_0^{\infty}e^{-x}L_m(x)L_n(x)dx=\delta_{mn}$$ **(5)**

Q7 **a)** Show that Sturm-Liouville operator is Hermitian. **(5)**

b) Show that any differential equation can be reduced to Sturm- Liouville form. **(5)**

Q8 **a)** Write in Sturm-Liouville form and identify $p(x),q(x),and\ w(x)$ in the following equation: **(5)**

$$(1-x^2)y''-xy'+\lambda y(x)=0$$

b) Show that the eigenvalues and the corresponding eigenfunction of the Sturm-Liouville differential equation **(5)**

$x^2u''+xu'+\lambda u(x)=0$ with $1\le x\le e^2;\ u(1)=0;and\ u(e^2)=0$