ST. THOMAS COLLEGE, PALAI

UGC APPROVED COLLEGE WITH POTENTIAL FOR EXCELLENCE
RE-ACCREDITED BY NAAC WITH 'A++' GRADE (CGPA 3.56)
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MECHANISM ;
INTERNAL EXAMINATION
2020-2021

CONTENTS

EXAMINATION CALENDAR
2020-2021

EXAMINATION CALENDAR 2020-2021

EXAMINATION CALENDAR FOR THE AY 2019-2020					
Sl. No.	***Name of the Course***	***Class***	***First/ Second Internal/ Model***	***Date of Uty. Exam***	***Date of Announcement of Results***
1.	UG (Supply)	4th Semester Supply Examination (Old Scheme)	-	01/07/2020	12/11/2020
2.	UG (R/S)	4th Semester Examination	08/06/2020	01/07/2020	09/11/2020
3.	PG	4th Semester Examination	08/06/2020	01/07/2020	26/10/2020
4.	PG(R/S)	4th Semester Examination	09/06/2020	02/07/2020	26/10/2020
5.	UG(Supply)	4th Semester Supply Examination (Old Scheme)	-	03/07/2020	12/11/2020
6.	UG(R/S)	4th Semester Examination	09/06/2020	03/07/2020	09/11/2020
7.	UG (R/S)	4th Semester Examination	10/06/2020	06/07/2020	09/11/2020
8.	PG	4th Semester Examination	10/06/2020	06/07/2020	26/10/2020
9.	PG(R/Imp)	4th Semester Examination	11/06/2020	07/07/2020	26/10/2020
10.	PG(R/Imp)	4th Semester Examination	12/06/2020	08/07/2020	26/10/2020
11.	PG(R/Imp)	4th Semester Examination	15/06/2020	09/07/2020	26/10/2020
12.	PG(R)	4th Semester Examination	16/06/2020	10/07/2020	26/10/2020
13	PG (R)	4th Semester Examination	17/06/2020	15/07/2020	26/10/2020
14	PG (R)	4th Semester Examination	18/06/2020	16/07/2020	26/10/2020
15	PG (R)	4th Semester Examination	19/06/2020	17/07/2020	26/10/2020
16	PG (R)	4th Semester Examination	22/06/2020	23/07/2020	26/10/2020
17	PG (R)	4th Semester Examination	24/06/2020	24/07/2020	26/10/2020
18	PG (R)	4th Semester Examination	25/06/2020	27/07/2020	26/10/2020
19	PG (S)	1st Semester Supply Examination	-	04/11/2020	09/03/2021
20	UG(B. Voc)	1st Semester Regular Examination	05/10/2020	04/11/2020	22/03/2021
21	PG (S)	1st Semester Supply Examination	-	06/11/2020	09/03/2021
22	UG(B. Voc)	1st Semester Regular Examination	06/10/2020	06/11/2020	22/03/2021
23	PG (S)	1st Semester Supply Examination	-	09/11/2020	09/03/2021
24	UG(B. Voc)	1st Semester Regular Examination	07/10/2020	09/11/2020	22/03/2021
25	PG (S)	1st Semester Supply Examination	-	11/11/2020	09/03/2021
26	UG(B. Voc)	1st Semester Regular Examination	08/10/2020	11/11/2020	22/03/2021
27	PG (S)	1st Semester Supply Examination	-	13/11/2020	09/03/2021
28	UG(B. Voc)	1st Semester Regular Examination	09/10/2020	13/11/2020	22/03/2021
29	UG(R/S/P)	2nd Semester Examination	26/10/2020	25/11/2020	05/04/2021
30	UG(R/S/P)	2nd Semester Examination	27/10/2020	27/11/2020	05/04/2021
31	UG(R/S/P)	2nd Semester Examination	28/10/2020	30/11/2020	05/04/2021
32	PG(R/S)	2nd Semester Regular Examination	03/11/2020	30/11/2020	29/03/2021
33	UG(R/S/P)	2nd Semester Regular Examination	29/10/2020	01/12/2020	05/04/2021
34	UG (Supply)	6th Semester Botany Mercy Chance	-	02/12/2020	02/02/2021
35	UG(R/S/P)	2nd Semester Examination	30/10/2020	02/12/2020	05/04/2021
36	PG(R/S)	2nd Semester Regular Examination	04/11/2020	02/12/2020	29/03/2021
37	UG(R/S/P)	2nd Semester Regular Examination	03/11/2020	03/12/2020	05/04/2021
38	UG(R/S/P)	2nd Semester Examination	04/11/2020	29/12/2020	05/04/2021
39	PG(R/S)	2nd Semester Regular Examination	05/11/2020	29/12/2020	29/03/2021
40	UG(R/S/p)	2nd Semester Regular Examination	05/11/2020	30/12/2020	05/04/2021
41	PG(R/S)	2nd Semester Regular Examination	06/11/2020	31/12/2020	29/03/2021

42	UG(R/S/p)	2nd Semester Regular Examination	06/11/2020	01/01/2021	05/04/2021
43	PG(R/S)	2nd Semester Regular Examination	09/11/2020	01/01/2021	29/03/2021
44	UG(R/S/p)	2nd Semester Regular Examination	09/11/2020	05/01/2021	05/04/2021
45	UG(R/S/p)	2nd Semester Regular Examination	10/11/2020	07/01/2021	05/04/2021
46	PG	2nd Semester Imp & Supply Examination	11/11/2020	14/01/2021	29/03/2021
47	UG (B. Voc)	3rd Sem B. Voc UG Examination	03/12/2020	20/01/2021	22/04/2021
48	BA/B. Com	3rd Semester BA /B. Com Pvt Examination	-	20/01/2021	21/04/2021
49	UG (B. Voc)	3rd Sem B. Voc UG Examination	04/12/2020	22/01/2021	22/04/2021
50	BA (PVT)	3rd Semester BA Pvt Examination	-	22/01/2021	21/04/2021
51	UG (B. Voc)	3rd Sem B. Voc UG Examination	07/12/2020	27/01/2021	22/04/2021
52	BA/B. Com	3rd Semester BA /B. Com Pvt Examination	-	27/01/2021	21/04/2021
53	UG (B. Voc)	3rd Sem B. Voc UG Examination	08/12/2020	29/01/2021	22/04/2021
54	B. Com (PVT)	3rd Semester B. Com Pvt Examination	-	29/01/2021	21/04/2021
55	UG(R/Imp)	5th Semester UG (R/Imp) Examination	11/01/2021	01/02/2021	03/05/2021
56	UG(PVT)	3rd Semester UG Examination	-	01/01/2021	21/04/2021
57	UG(B. Voc)	3rd Sem B. Voc UG Examination	09/12/2020	01/01/2021	22/04/2021
58	UG(R/IMP)	5th Semester UG Examination	12/01/2021	03/02/2021	03/05/2021
59	UG (B. Voc)	3rd Sem B. Voc UG Examination	10/12/2020	03/02/2021	22/04/2021
60	UG(PVT)	3rd Semester UG Examination	-	03/02/2021	21/04/2021
61	UG(R/IMP)	5th Semester UG Examination	13/01/2021	05/02/2021	03/05/2021
62	UG (B. Voc)	3rd Sem B. Voc UG Examination	11/12/2020	05/02/2021	22/04/2021
63	UG(PVT)	3rd Semester UG Examination	-	05/02/2021	21/04/2021
64	UG(R/IMP)	3rd Semester UG Examination	14/12/2020	09/02/2021	21/04/2021
65	UG (S)	2nd Semester UG Examination	-	10/02/2021	02/04/2021
66	UG(PVT)	4th Semester UG Examination	-	10/02/2021	07/05/2021
67	UG(R/IMP)	5th Semester UG Examination (Open Course)	15/12/2020	12/02/2021	03/05/2021
68	UG(PVT)	4th Semester UG Examination	-	12/02/2021	07/05/2021
69	UG(S&M)	2nd Semester UG Examination (Supply & Mercy)	-	15/02/2021	22/04/2021
70	UG(PVT)	4th Semester UG Examination	-	15/02/2021	07/05/2021
71	UG(S&M)	2nd Semester UG Examination (Supply & Mercy)	-	17/02/2021	22/04/2021
72	UG(PVT)	4th Semester UG Examination	-	17/02/2021	07/05/2021
73	UG(B. Voc)	2nd Semester B. Voc Examination	18/01/2021	18/02/2021	06/05/2021
74	UG(S&M)	2nd Semester UG Examination (Supply & Mercy)	-	19/02/2021	22/04/2021
75	UG(PVT)	4th Semester UG Examination	-	19/02/2021	07/05/2021
76	UG(S&M)	2nd Semester UG Examination (Supply & Mercy)	-	22/02/2021	22/04/2021
77	UG(B. Voc)	2nd Semester B. Voc Examination	19/01/2021	22/02/2021	06/05/2021
78	UG(PVT)	4th Semester UG Examination	-	22/02/2021	07/05/2021
79	UG(B. Voc)	2nd Semester B. Voc Examination	20/01/2021	24/02/2021	06/05/2021
80	UG(B. Voc)	2nd Semester B. Voc Examination	21/01/2021	26/02/2021	06/05/2021
81	UG(S)	2nd Semester UG Supply Examination	-	26/02/2021	22/04/2021
82	PG(PVT)	3rd Semester PG Examination	-	26/02/2021	21/05/2021
83	UG(PVT)	1st Semester UG Examination	-	27/02/2021	07/05/2021
84	UG(B. Voc)	2nd Semester B. Voc Examination	22/01/2021	01/03/2021	06/05/2021
85	UG(B. Voc)	2nd Semester B. Voc Examination	25/01/2021	01/03/2021	06/05/2021
86	UG(S)	2nd Semester UG Supply Examination	-	01/03/2021	22/04/2021
87	PG(PVT)	3rd Semester PG Examination	-	01/03/2021	21/05/2021
88	UG(PVT)	1st Semester UG Examination	-	01/03/2021	04/07/2021
89	PG(PVT)	3rd Semester PG Examination	-	03/03/2021	21/05/2021
90	UG(PVT)	1st Semester UG Examination	-	03/03/2021	04/07/2021
91	PG(PVT)	3rd Semester PG Examination	-	05/03/2021	21/05/2021

92	UG(PVT)	1st Semester UG Examination	-	05/03/2021	04/06/2021
93	UG(PVT)	4TH Semester UG PVT Examination	-	08/03/2021	11/06/2021
94	UG(PVT)	1st Semester UG Examination	-	08/03/2021	04/06/2021
95	UG(PVT)	1st Semester UG Examination	-	10/03/2021	04/06/2021
96	UG(PVT)	3rd Semester UG PVT Examination	-	10/03/2021	10/06/2021
97	UG(PVT)	4TH Semester UG PVT Examination	-	10/03/2021	11/06/2021
98	PG(PVT)	4th Semester PG PVT Examination	-	12/03/2021	29/06/2021
99	UG(S)	3rd Semester UG Supply Examination	-	12/03/2021	10/06/2021
100	UG(PVT)	1st Semester UG PVT Examination	-	12/03/2021	04/06/2021
101	PG	3rd Semester PG Examination	15/02/2021	15/03/2021	16/07/2021
102	PG(PVT)	4th Semester PG PVT Examination	-	15/03/2021	29/06/2021
103	UG(Imp/S)	3rd Semester UG Examination	-	15/03/2021	10/06/2021
104	UG(PVT)	1st Semester UG Examination	-	15/03/2021	04/06/2021
105	UG(B. Voc)	4th Semester B. Voc Examination	15/02/2021	16/03/2021	07/07/2021
106	UG(Imp/S)	3rd Semester UG Examination	-	16/03/2021	10/06/2021
107	PG(PVT)	4th Semester PG PVT Examination	-	17/03/2021	29/06/2021
108	UG(Imp/S)	3rd Semester UG Examination	-	17/03/2021	10/06/2021
109	UG(PVT)	1st Semester UG Examination	-	17/03/2021	04/06/2021
110	PG	3rd Semester PG Examination	16/02/2021	18/03/2021	16/07/2021
111	UG(B. Voc)	4th Semester B. Voc Examination	16/02/2021	18/03/2021	07/07/2021
112	UG(Imp/S)	3rd Semester UG Examination	-	18/03/2021	10/06/2021
113	PG(PVT)	4th Semester PG PVT Examination	-	19/03/2021	29/06/2021
114	UG(PVT)	1st Semester UG Examination	-	19/03/2021	04/06/2021
115	UG(B. Voc)	4th Semester B. Voc Examination	17/02/2021	20/03/2021	07/07/2021
116	UG(Imp/S)	3rd Semester UG Examination	-	20/03/2021	10/06/2021
117	PG(PVT)	4th Semester PG PVT Examination	-	22/03/2021	29/06/2021
118	PG	3rd Semester PG Examination	17/02/2021	22/03/2021	16/07/2021
119	UG(B. Voc)	4th Semester B. Voc Examination	18/02/2021	22/03/2021	07/07/2021
120	UG(Imp/S)	3rd Semester UG Examination	-	22/03/2021	10/06/2021
121	UG(PVT)	1st Semester UG Examination	-	22/03/2021	05/08/2021
122	PG(PVT)	4th Semester PG PVT Examination	-	23/03/2021	29/06/2021
123	UG(S/imp)	5th Semester UG Examination	-	23/03/2021	18/06/2021
124	UG(B. Voc)	4th Semester B. Voc Examination	19/02/2021	24/03/2021	07/07/2021
125	PG(PVT)	4th Semester PG PVT Examination	-	24/03/2021	29/06/2021
126	UG(PVT)	2nd Semester UG PVT Examination	-	24/03/2021	06/08/2021
127	PG(R/imp)	3rd Semester PG Examination	19/02/2021	25/03/2021	16/07/2021
128	PG(PVT)	4th Semester PG PVT Examination	-	25/03/2021	29/06/2021
129	UG (B. Voc)	1st Semester UG B. Voc Examination	01/03/2021	27/03/2021	05/08/2021
130	PG(R/imp)	3rd Semester PG Examination	22/02/2021	29/03/2021	16/07/2021
131	UG(S)	5th Semester UG Supply Examination	-	29/03/2021	18/06/2021
132	UG (B. Voc)	1st Semester UG B. Voc Examination	02/03/2021	29/03/2021	05/08/2021
133	PG(PVT)	4th Semester PG PVT Examination	-	30/03/2021	29/06/2021
134	UG(S/imp)	4th Semester UG Supply /Imp Examination	-	30/03/2021	02/07/2021
135	PG(PVT)	3rd Semester PG PVT Examination	-	31/03/2021	16/07/2021
136	UG(S/imp)	5TH semester UG Supply Examination	-	31/03/2021	18/06/2021
137	UG (B. Voc)	1st Semester UG B. Voc Examination	03/03/2021	31/03/2021	05/08/2021
138	UG (PVT)	1ST Semester PVT Examination	-	31/03/2021	05/08/2021
139	UG (B. Voc)	1st Semester UG B. Voc Examination	04/03/2021	08/04/2021	05/08/2021
140	UG(S/imp)	4th Semester UG Supply /Imp Examination	-	09/04/2021	02/07/2021
414	UG (B. Voc)	1st Semester UG B. Voc Examination	05/03/2021	12/04/2021	05/08/2021
142	UG(S/imp)	4th Semester UG Supply /Imp Examination	-	13/04/2021	02/07/2021
143	UG(S/imp)	4th Semester UG Supply /Imp Examination	-	15/03/2021	02/07/2021
144	UG (B. Voc)	4th Semester UG B. Voc Examination	15/03/2021	16/04/2021	07/07/2021

145	PG(PVT)	4th Semester PG PVT Examination	-	16/04/2021	29/06/2021
146	UG(S/imp)	4th Semester UG Supply /Imp Examination	-	16/04/2021	02/07/2021
147	UG(PVT)	2ND Semester UG PVT Examination	-	16/04/2021	06/08/2021
148	UG(S/imp)	4th Semester UG Supply /Imp Examination	-	17/04/2021	02/07/2021
149	UG(R/S/PVT)	6th Semester UG Examination (R/IMP/PVT)	22/03/2021	28/06/2021	03/09/2021
150	UG (B. Com)	6th Semester UG B. Com Examination	15/03/2021	29/06/2021	03/09/2021
151	UG(R/S/PVT)	6th Semester UG Examination (R/IMP/PVT)	16/03/2021	30/06/2021	03/09/2021

MODEL QUESTION PAPERS - INTERNAL EXAMINATION

2020-2021

1. PH1CMT01 - PROPERTIES OF MATTER AND ERROR ANALYSIS
2. PH3CRT03 - OPTICS, LASER AND FIBER OPTICS
3. PH5CRT08 - ENVIRONMENTAL PHYSICS AND HUMAN RIGHTS
4. PH5OPT02 - PHYSICS IN DAILY LIFE

ST.THOMAS COLLEGE PALA

BSc DEGREE (CBCSS) EXAMINATION (INTERNAL) FEBRUARY 2021

First Semester

PH1CMT01 – PROPERTIES OF MATTER AND ERROR ANALYSIS

Complementary Physics for Mathematics

Time: 1.5 hours **Maximum Marks: 30**

Part A: *Answer any 5 questions*

1. Briefly discuss the terms stress and strain. Mention their units.
2. Distinguish between angle of twist and angle of shear using a neat diagram showing the two terms.
3. What are the factors affecting the surface tension of a liquid?
4. Write down Poiseuille's equation. Explain the terms involved.
5. What do you mean by parallax error ?
6. Explain the standard deviation of a data ? **(5 x 1 = 5)**

Part B: (Short Questions): *Answer any 3 questions*

7. Calculate the work done in stretching a wire of length 1 m and cross-section 1 mm^2 through 1 mm. Young's modulus of the material is 200 GPa.
8. Calculate the energy released when 8 droplets of water of radius 0.5 mm coalesce to form a single drop. Given, surface tension of water = 0.072 N/m.
9. Water flows through a pipe of 0.04 m radius and 2 km in length at the rate of 100 litres per minute. Determine the pressure required to maintain the flow, if the coefficient of viscosity is 10^{-3} Ns/m^2 and atmospheric pressure is 1.01×10^5 N/m^2.
10. The length, breadth and thickness of a rectangular sheet are 4.234 m, 1.005 m and 2.01 cm respectively. Determine the area and volume of the sheet to the correct significant figures.
11. Two resistors $R_1 = 100\pm3\Omega$ and $R_2 = 200\pm4\Omega$ are connected in a) series and b) parallel. Determine the equivalent resistance in each case. **(3 x 5 = 15)**

Part C: (Essays): *Answer any 1 question*

12. What is a cantilever? Derive an expression for the depression at the loaded end of a cantilever.
13. Discuss the rules adopted in calculating the error when the numbers with errors are added, subtracted, multiplied, divided or raised to some power.

(10X 1 =10)

ST. THOMAS COLLEGE PALAI

B.Sc DEGREE (CBCSS) EXAMINATION (Model) MARCH 2021

Third Semester

PH3CRT03:– OPTICS, LASER AND FIBER OPTICS

Time: 3 hours **Maximum Marks: 70**

Part A: ***Answer any 10 questions***

1. What is the reason for highly information carrying capacity of a hologram?
2. Two independent sources of light cannot be coherent. Why?
3. Laser beam is highly directional. Explain.
4. What is the nature of the central spot of Newton's rings system in reflected light? Explain the reason.
5. Explain why spiking occurs in lasers?
6. In Newton's rings experiment, the diameter of fourth ring is 4×10^{-3}m. Calculate the diameter of the 20^{th} ring?
7. Explain the term acceptance angle in optical fibers.
8. Consider a beam of light of wavelength λ incident on a system of a polarizer and an analyzer. The analyzer is oriented at 45° to the polarizer. When an optical component is introduced between them, the output intensity becomes zero. (Light is incident normally on all components). The optical component is
9. White light is incident on a grating G1 with groove density 600 lines/mm and width 50 A small portion of the diffracted li mm. ght is incident on another grating G2 with groove density 1800 lines/mm and width 15 mm. The resolving power of the combined system is
10. Snell's law is an outcome of which principle?
11. What are polaroids? Mention two applications
12. Why is it difficult to get laser light at high frequencies?

(10X 2 = 20)

Part B: (Short Questions): ***Answer any 6 questions***

13. Two coherent sources are 0.18mm apart and the fringes are observed on a screen 0.8m away. It is found that with a certain monochromatic source of light the fourth bright fringe is observed at a distance of 10.8 mm from the central fringe. Calculate the wavelength of light.

ST. THOMAS COLLEGE PALAI

BSc DEGREE (CBCS) EXAMINATION (MODEL) JANUARY 2021

Fifth Semester

PH5CRT08 – ENVIRONMENTAL PHYSICS AND HUMAN RIGHTS

Time: 3 hours **Maximum Marks: 60**

Part A: *Answer any 10 questions*

1. What are the three R's of waste management?
2. How the irradiance is dependent on the angle of incidence of the sunlight?
3. Give two applications of solar ponds.
4. What is a direct type solar dryer?
5. What is a flat plate collector?
6. Give two examples of hazardous solid wastes.
7. Distinguish between surface water and ground water.
8. What are the important characteristics of human rights?
9. Define article 26 of UDHR
10. Name the main categories of floods.
11. What do you mean by space borne sensing?
12. DefineScatterometer.

(10 X 1 = 10)

Part B: (Short Questions): *Answer any 6 questions*

13. How is waste minimization achieved through promotional methods?
14. Explain the physical methods of waste treatment.
15. Discuss the Air (Prevention and Control of Pollution) Act of 1981.
16. What is an optical concentrator and explain the different types.
17. Explain the passive and active space heating systems.
18. Explain different types of renewable and nonrenewable energy resources.
19. Describe the main procedures of remote sensing.
20. What are the important characteristics of human rights?
21. What are the distinct features of oblique and vertical images of aerial photography?

(6 X 5 = 30)

ST. THOMAS COLLEGE PALAI

Model Examination – January 2021

SEMSTER V - OPEN COURSE PHYSICS

PH5OPT02: Physics in Daily Life

Time: 3 hours **Maximum Marks: 80**

Part A (Short Answer/problem type) (Answer any 10) (2 Mark each)

1. Distinguish between precision and accuracy.
2. Define total internal reflection.
3. Explain population standard deviation.
4. Define optical power of lens.
5. Explain the terms, displacement, velocity and acceleration.
6. Distinguish between the terms, mass and weight.
7. Explain Ohm's law.
8. Distinguish between adhesive and cohesive forces.
9. Write a note on different types of sound waves
10. Discuss the use of GPS.
11. Write short note on constellations.
12. Distinguish between geostationary and geosynchronous satellites.

(10×2=20)

Part B: (Short Essay/Problem) (Answer any six) (5 Marks each)

13. Distinguish between convex and concave mirror.
14. Explain different types of errors.
15. Distinguish between Rayleigh scattering and Mie scattering.
16. Explain the basic principles of LASER
17. Explain different types of temperature scales.
18. Explain nuclear fusion and fission.
19. Draw the schematic of a solar cell. Discuss its advantages and disadvantages.
20. Distinguish between solar and lunar eclipses.
21. Using a suitable diagram, discuss HR diagram of stars.

(6×5=30)

Part C: (Essay/Problem) (Answer any two) (15 Marks each)

22. What are the defects of eye? How can be corrected these defects?
23. What is viscosity? Explain Bernoulli's theorem and its applications.
24. Explain the working principle of a hydroelectric power station using a suitable figure.
25. Discuss the evolution of stars illustrating the different stages involved.

(2×15=30)

MODEL ANSWER SCRIPT
2020-2021

Name of the Student: Liya Babu

Class Number: 67

Name of the Programme: M.Sc. Physics

Name of the Course: Mathematical Physics - I

Date: 18. 01. 2021

ST. THOMAS COLLEGE, PALA

PG INTERNAL / MODEL EXAMINATION

Name of the student : Liya Babu Class Number: 67

Name of the Programme: M.Sc. Physics Semester: I

Name of the Course: Mathematical Physics - I Date: 18.01.2021

GRADE (To be filled by the Examiner) A

Question Numbers	Grade Awarded	Grade Points	Weight	Weighted Grade Points	
1	A+	5	1	5	
2	A+	5	1	5	
3	A+	5	1	5	
4	A	4	1	4	36
5	A+	5	1	5	
6	A	4	1	4	
7	A	4	1	4	
8	A	4	1	4	
9	A	4	2	8	
10	A+	5	2	10	
11	A+	5	2	10	50
12	A+	5	2	10	
13	A	4	2	8	
14	C	2	2	4	
15	A+	5	5	25	
16	A	4	5	A$ 20	45
17					
18					
19					
20					
21					
22					
23					
24					
				131	
Sum of the weighted grade points / *Total Weight*				131/150	4.36

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Part-A

1. We consider a function called inner product by which we can make the numbers from vectors. A vector space equipped with inner product is called an inner product space. The inner product of two vectors is defined as,

$$\vec{a}\cdot\vec{b} = a_1b_1 + a_2b_2 + a_3b_3, \quad \text{where} \quad \vec{a} = a_1\hat{i} + a_2\hat{j} + a_3\hat{k}$$
$$\vec{b} = b_1\hat{i} + b_2\hat{j} + b_3\hat{k}.$$

AX

Properties of inner product space

i) $\vec{a}\cdot\vec{a} \geq 0$, for all $\vec{a}$ ✓

ii) $\vec{a}\cdot\vec{a} = 0$, if $\vec{a} = 0$. ✓

iii) $\vec{a}\cdot(x+y) = \vec{a}\cdot x + \vec{a}\cdot y$ ✓

iv) $\vec{a}\cdot(\alpha b) = \alpha(\vec{a}\cdot\vec{b})$

v) $\vec{a}\cdot\vec{b} = \vec{b}\cdot\vec{a}$

The norm of a vector is defined as,

$$|\vec{a}| = \sqrt{a_1^2 + a_2^2 + \cdots a_n^2}$$

$$|\vec{a}|^2 = a_1^2 + a_2^2 + \cdots a_n^2$$ ✓

$$= \vec{a}\cdot\vec{a}$$

2. Stoke's theorem relates line and surface integrals. It states that,

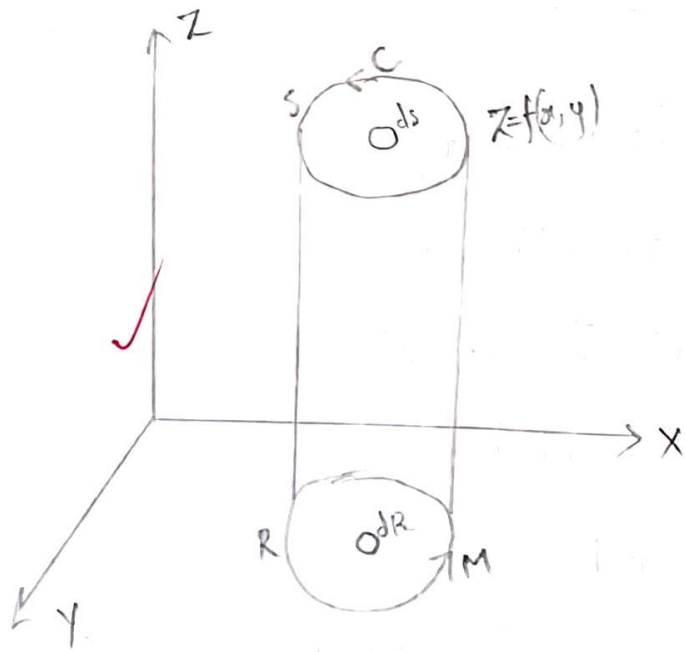
For a vector function, the tangential line integral of a function around a closed curve 'c' enclosing a surface 's' is equal to the normal surface integral of curl of that function over that enclosed surface.

ie.

$$\iint_S (\nabla \times F) \cdot \hat{n}\, ds = \oint_C F \cdot dr$$

Proof.

Let 's' be a surface bounded by curve 'c'. The projection of 's' on xy plane be R, bounded by the curve M. Let $\hat{n}$ be defined as $\hat{n} = f(x,y)$



Let $F = F_1\hat{i} + F_2\hat{j} + F_3\hat{k}$

$$(\nabla \times F_1)\cdot\hat{i} = \begin{vmatrix} i & j & k \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ F_1 & 0 & 0 \end{vmatrix} = -j\left(\frac{-\partial F_1}{\partial z}\right) + \hat{k}\left(\frac{-\partial F_1}{\partial y}\right)$$

$$= \frac{\partial F_1}{\partial z}\hat{j} - \frac{\partial F_1}{\partial y}\hat{k}$$

$$(\nabla \times F_1) \cdot \hat{i} \cdot \hat{n}\, ds = \left(\frac{\partial F_1}{\partial z}\, \hat{j} \cdot \hat{n} - \frac{\partial F_1}{\partial y}\, \hat{k} \cdot \hat{n}\right) ds \quad -(1)$$

Let $\vec{r}$ be a point on the surface S,

$$\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$$

$$\frac{\partial r}{\partial y} = \frac{\partial x}{\partial y}\hat{i} + \frac{\partial y}{\partial y}\hat{j} + \frac{\partial z}{\partial y}\hat{k}$$

z is a function of x, y but x is not function of y

$$\frac{\partial r}{\partial y} = \hat{j} + \frac{\partial z}{\partial y}\hat{k}$$

$$\hat{n} \cdot \frac{\partial r}{\partial y} = \hat{n} \cdot \hat{j} + \frac{\partial z}{\partial y}\hat{n} \cdot \hat{k}$$

$\vec{r}$ is a point xy plane but $\hat{n}$ is a unit vector projected to plane z.

$\therefore$ angle between them is $90°$.

$$\hat{n} \cdot \hat{j} = -\frac{\partial z}{\partial y}\hat{n} \cdot \hat{k} \quad -(2)$$

Sub (2) in (1)

$$(\nabla \times F_1) \cdot \hat{i} \cdot \hat{n}\, ds = \left(\frac{\partial F_1}{\partial z}\left(-\frac{\partial z}{\partial y}\hat{n} \cdot \hat{k}\right) - \frac{\partial F_1}{\partial y}\hat{n} \cdot \hat{k}\right) ds$$

$$= -\left(\frac{\partial F_1}{\partial y} + \frac{\partial F_1}{\partial z}\frac{\partial z}{\partial y}\right)\hat{n} \cdot \hat{k}\, ds. \quad -(3)$$

F_1 is a function of x, y, z, but z is a function of x, y. Therefore,

$$F_1(x, y, z) = \phi(x, y)$$

$$\frac{\partial \phi}{\partial y} = \frac{\partial F_1}{\partial y} + \frac{\partial F_1}{\partial z}\frac{\partial z}{\partial y}$$

Comparing with (3)

$$(\nabla \times F_1) \cdot \hat{i} \cdot \hat{n}\, ds = -\frac{\partial \phi}{\partial y}\hat{n} \cdot \hat{k}\, ds = -\frac{\partial \phi}{\partial y}\, dx\, dy$$

$$(\hat{n} \cdot \hat{k}\, ds - dx\, dy)$$

$$\iint (\nabla \times F_1) \hat{i} \cdot \hat{n}\, ds = \iint -\frac{\partial \phi}{\partial y}\, dx\, dy \quad \text{— (4)}$$

From Green's theorem,

$$\oint M\,dx + N\,dy = \iint_S \left(\frac{\partial N}{\partial x} - \frac{\partial M}{\partial y}\right) dx\, dy$$

put $M = \phi$ and $N = 0$.

$$\oint \phi\, dx = \iint_S -\frac{\partial \phi}{\partial y}\, dx\, dy$$

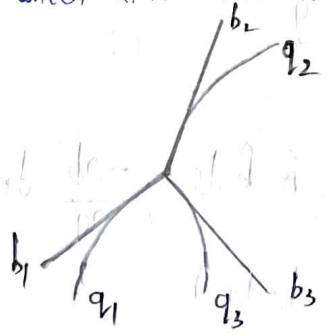
So, from (4),

$$\iint (\nabla \times F_1) \hat{i} \cdot \hat{n}\, ds = \oint \phi\, dx = \oint F_1\, dx.$$

∴ This can be, in general written as,

$$\iint_S (\nabla \times F) \cdot \hat{n}\, ds = \oint F\, dx$$

3. The physical laws can be best expressed in terms of vectors, But vectors need to be in appropriate coordinates. A point $P(x, y, z)$ in cartesian system is represented by three mutually perpendicular axes. Likewise, in curvilinear coordinate system, a point is represented by three orthogonal coordinate surfaces (q_1, q_2, q_3). The intersection of three mutually perpendicular curves is called coordinate lines, and the tangent to which at the intersection of three curves is called coordinate axes.



Let $\vec{r}$ be a vector defined by,

$$\vec{r} = \vec{r}(q_1, q_2, q_3 \ldots q_n)$$

$$d\vec{r} = \frac{\partial \vec{r}}{\partial q_1} dq_1 + \frac{\partial \vec{r}}{\partial q_2} dq_2 + \frac{\partial \vec{r}}{\partial q_3} dq_3$$

$$d\vec{r} = b_1 dq_1 + b_2 dq_2 + b_3 dq_3 \quad \text{---(1)}$$

b_i is the base vector which points in the direction of change of r_i which depends on coordinates q_1, q_2, q_3.

A unit vector can be defined as,

$$\hat{q}_i = \frac{\frac{\partial r_i}{\partial q_i}}{\left|\frac{\partial r_i}{\partial q_i}\right|} = \frac{b_i}{|b_i|} = \frac{b_i}{h_i}$$

$$\therefore (1) \Rightarrow d\vec{r} = h_1 dq_1 \hat{q}_1 + h_2 dq_2 \hat{q}_2 + h_3 dq_3 \hat{q}_3.$$

The gradient of a scalar in orthogonal curvilinear coordinates can then be defined in terms of q_1, q_2, q_3 as,

In cartesian system,

$$\nabla\phi = \frac{\partial \phi}{\partial x}\hat{i} + \frac{\partial \phi}{\partial y}\hat{j} + \frac{\partial \phi}{\partial z}\hat{k}$$

Similarly in curvilinear coordinates,

$$\nabla\phi = \frac{\partial \phi}{h_1 \partial q_1}\hat{q}_1 + \frac{\partial \phi}{h_2 \partial q_2}\hat{q}_2 + \frac{\partial \phi}{h_3 \partial q_3}\hat{q}_3$$

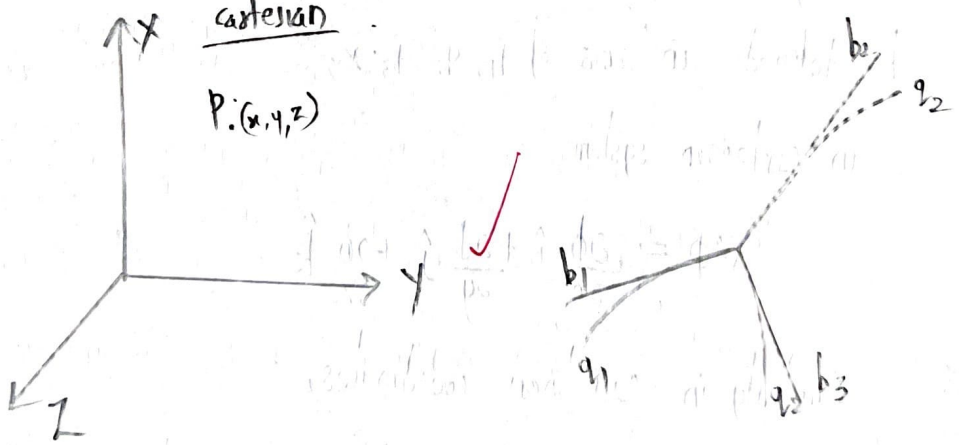
where the operator is given by,

$$\nabla = \frac{\partial}{h_1 \partial q_1}\hat{q}_1 + \frac{\partial}{h_2 \partial q_2}\hat{q}_2 + \frac{\partial}{h_3 \partial q_3}\hat{q}_3$$

4.

The physical laws can be best expressed in terms of vectors. The vectors need to be represented in terms of appropriate coordinates before solving the physical problem. For example, the motion of a particle in central force field has spherical symmetry. Hence, the use of spherical polar coordinates are best suited and the use of cylindrical coordinates is best of a charged particle moving in a helical path.

In cartesian coordinate system, a point is defined by three mutually perpendicular axes (x, y, z). In curvilinear coordinates, a point (q_1, q_2, q_3) are charecterised by three orthogonal coordinate surfaces. The intersection of three mutually perpendicular curves is called coordinate lines and the tangents to which at the intersection gives coordinate axes.



Element of displacement

Let $\vec{r}$ be a point defined as,

$$\vec{r} = \vec{r}(q_1, q_2, q_3)$$

$$dr = \frac{\partial r}{\partial q_1} dq_1 + \frac{\partial r}{\partial q_2} dq_2 + \frac{\partial r}{\partial q_3} dq_3 = b_1 dq_1 + b_2 dq_2 + b_3 dq_3$$

b_i is a base vector which directs along the change of r_i.

A unit vector can be defined as

$$\hat{q}_i = \frac{\partial r / \partial q_i}{\left| \partial r / \partial q_i \right|} \quad \frac{b_i}{|b_i|} = \frac{b_i}{h_i}$$

$$\therefore dr = h_1 dq_1 \hat{q}_1 + h_2 dq_2 \hat{q}_2 + h_3 dq_3 \hat{q}_3$$

Curvilinear coordinates is a family of surfaces which intersects others at right angles.

5. Gauss divergence theorem

The divergence of a vector function $\vec{F}$ over a volume V is equal to the surface integral of $\vec{F}$ around any closed surface S surrounding a volume V.

$$\iiint_V (\nabla \cdot F)\, dV = \iint_S F \cdot ds.$$

Proof

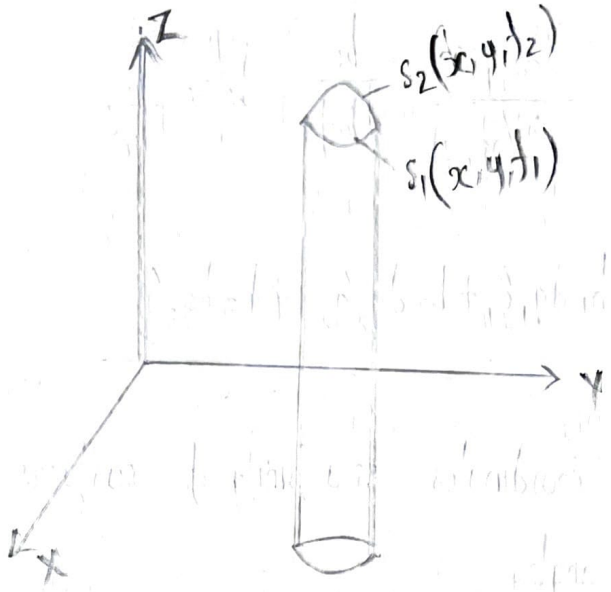
Let $\vec{F} = F_1 \hat{i} + F_2 \hat{j} + F_3 \hat{k}$

$$\nabla \cdot \vec{F} = \frac{\partial F_1}{\partial x} + \frac{\partial F_2}{\partial y} + \frac{\partial F_3}{\partial z}$$

$$\iiint_V \nabla \cdot \vec{F}\, dV = \iiint_V \left(\frac{\partial F_1}{\partial x} + \frac{\partial F_2}{\partial y} + \frac{\partial F_3}{\partial z} \right) dx\, dy\, dz$$

$$= \iiint_V \frac{\partial F_1}{\partial x} dx\, dy\, dz + \iiint_V \frac{\partial F_2}{\partial y} dx\, dy\, dz + \iiint_V \frac{\partial F_3}{\partial z} dx\, dy\, dz$$

consider a strip parallel to z axis which touch the upper surface of volume at S_2 and lower surface at S_1



consider,

$$\iiint_V \frac{\partial F_3}{\partial z}\,dx\,dy\,dz = \iint \int_{f_1}^{f_2} \frac{\partial F_3}{\partial z}\,dz\,dx\,dy$$

$$= \iint \left(F_3(x,y,f_2) - F_3(x,y,f_1)\right) dx\,dy$$

Taking the outward normal flux over a surface as +ve and inward normal flux as -ve,

$\hat{n}\cdot\hat{k}\,ds = dx\,dy$ (upper surface)

$\hat{n}\cdot\hat{k}\,ds = -dx\,dy$ (Lower ")

$$\therefore \int_S \left(F_3(x,y,f_2) + F_3(x,y,f_1)\right) dx\,dy = \int_S F_3 \cdot ds = \iiint_V \frac{\partial F_3}{\partial z}\,dx\,dy\,dz$$

similarly,

$$\iiint_V \frac{\partial F_2}{\partial y}\,dx\,dy\,dz = \int_S F_2 \cdot ds.$$

$$\iiint_V \frac{\partial F_1}{\partial x}\,dx\,dy\,dz = \int_S F_1 \cdot ds.$$

In general,

$$\oint \iiint_V (\nabla \cdot F)\, dV = \oint F \cdot ds \cdot \iint_S F \cdot ds \cdot$$

6. Levi-civita tensor is a tensor quantity of rank three in a three dimensional space and it is a tensor quantity of rank 4 in a four dimensional space. It is also called Epsilon tensor, Alternate tensor and permutation tensor. In 3 dimensional space, it is represented as $\varepsilon_{\mu\nu\sigma}$ and four dimensional space $\varepsilon_{\mu\nu\sigma\lambda}$. It is an invariant tensor, independent of coordinate systems.

The properties of epsilon tensor is,

$$\varepsilon_{ijk} = \begin{cases} 1, & \text{even permutation} \\ -1, & \text{odd permutation} \\ 0, & \text{if an index repeats} \end{cases} = \varepsilon_{jik}$$

The permutations are,

$$\varepsilon_{123} = \varepsilon_{231} = \varepsilon_{312} = 1$$

$$\varepsilon_{213} = \varepsilon_{132} = \varepsilon_{321} = -1$$

$$\varepsilon_{111} = \varepsilon_{221} = \varepsilon_{311} = 0.$$

7. A matrix 'A' is said to be orthogonal when

$$A A^T = A^T A = I.$$

Let 'A' be an orthogonal matrix, A^T be the transpose of A.

checking the orthogonality condition,

$$A^T (A^T)^T = A^T A = I.$$

ie. A^T is also orthogonal.

eg. Let $A = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$

$$A^T = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

$$A A^T = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

ie. A is orthogonal.

$$A^T = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$$

$$A^T (A^T)^T = A^T A = \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} = \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$$

8. Central limit theorem has an important role in mathematics. We have the normal distribution function whose probability function is of the form,

$$f(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left(\frac{-1}{2}\left(\frac{x_i - \mu}{\sigma}\right)^2\right)$$

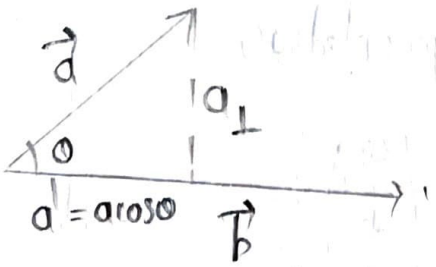
Central limit theorem states that the average of independent and identically distributed random variables with finite variance converges to a normal distribution irrespective of the distribution of original random variables. Let $X_1, X_2 \ldots$ be random variables with mean μ and variance $\sigma^2 > 0$. Then the sequence of random variables,

$$Z_n = \frac{\sum_{i=1}^{n} X_i - \mu}{\sigma\sqrt{n}}$$

converges in distribution to a standard normal random variable.

Part-B

9. Consider two vector $\vec{a}, \vec{b}$ at an angle θ. Let $a_\perp$ be the projection of $\vec{a}$ on $\vec{b}$.



$$a_\perp = \vec{a} - a' \quad \text{(Law of triangle addition)}$$

$$= \vec{a} - \frac{(\vec{a}\cdot\vec{b})\,\vec{b}}{\vec{b}\cdot\vec{b}}$$

Using the first property of inner product space,

$$\vec{a}\cdot\vec{a} \geq 0.$$

$$a_\perp \cdot a_\perp \geq 0.$$

$$\left(\vec{a} - \frac{(\vec{a}\cdot\vec{b})\vec{b}}{\vec{b}\cdot\vec{b}}\right)\left(\vec{a} - \frac{(\vec{a}\cdot\vec{b})\vec{b}}{\vec{b}\cdot\vec{b}}\right) \geq 0.$$

$$\vec{a}\cdot\vec{a} - \frac{\vec{a}(\vec{a}\cdot\vec{b})\vec{b}}{\vec{b}\cdot\vec{b}} - \frac{(\vec{a}\cdot\vec{b})\vec{b}\cdot\vec{a}}{\vec{b}\cdot\vec{b}} + \left(\frac{(\vec{a}\cdot\vec{b})\vec{b}\cdot\vec{b}}{\vec{b}\cdot\vec{b}}\right)^2 \geq 0.$$

$$\vec{a}\cdot\vec{a} - \frac{2(\vec{a}\cdot\vec{b})^2}{\vec{b}\cdot\vec{b}} + \frac{(\vec{a}\cdot\vec{b})^2}{\vec{b}\cdot\vec{b}} \geq 0.$$

$$(\vec{a}\cdot\vec{a})(\vec{b}\cdot\vec{b}) - (\vec{a}\cdot\vec{b})^2 \geq 0.$$

$$(\vec{a}\cdot\vec{a})(\vec{b}\cdot\vec{b}) \geq (\vec{a}\cdot\vec{b})^2$$

$$|\vec{a}||\vec{b}| \geq |\vec{a}\cdot\vec{b}|$$

10. A vector is a physical quantity having both magnitude and direction. A vector of magnitude 1 is called a unit vector. A vector can be represented as,

$$\vec{A} = \begin{pmatrix} a_1 \\ a_2 \\ a_3 \end{pmatrix}.$$

Let $\hat{e}_1, \hat{e}_2, \hat{e}_3$ be unit vectors used to represent a vector.

$$\hat{e}_1 = \begin{pmatrix} 1 \\ 0 \\ 0 \end{pmatrix} \quad \hat{e}_2 = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix} \quad \hat{e}_3 = \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix}$$

The dot product of two vectors can be written as,

$$\vec{a} \cdot \vec{b} = a_1 b_1 + a_2 b_2 + a_3 b_3$$

$$= \sum_{i=1}^{3} a_i b_i$$

Norm of $\vec{a} = (\vec{a} \cdot \vec{a})^{1/2}$.

Properties of linear vector space

A linear vector space consists of

i) $\mathbb{F}$ - a field of a scalar

ii) V - a set of elements called vectors

iii) A rule - Vector addition

a) $x + y = y + x$

b) $(x+y)+z = x+(y+z)$

c) $x + 0 = x$

d) If there exist a vector x' in a vectorspace, then there will be $-x$ such that $x + -x = 0$.

iv) A rule called vector multiplication,

a) $\vec{a} \cdot 1 = \vec{a}$

b) ~~$\vec{a}(\alpha+\beta) = a\alpha + a\beta$~~ $\vec{a}(\alpha+\beta) = a\alpha + a\beta$

c) $\vec{a}(\alpha+\beta) = \vec{a}(\alpha\beta) = \alpha(a\beta)$

d) $\alpha(\vec{a}+\vec{b}) = \alpha\vec{a} + \alpha\vec{b}$.

This is called a linear vector space.

A+

11. The process of generating a set of orthonormal vectors from linearly independent vectors is called gram - Schmidt orthonormalization.

Let $|x_1\rangle, |x_2\rangle \cdots |x_n\rangle$ be 'n' linearly independent variables and $|y_1\rangle, |y_2\rangle \cdots |y_n\rangle$ be a set of orthonormal vectors

Let $$|y_1\rangle = \frac{|x_1\rangle}{\|x_1\|} \quad -(1)$$

$$|y_2'\rangle = |x_2\rangle + \alpha |y_1\rangle \quad -(2)$$

Operating (2) with $\langle y_1|$

$$\langle y_1|y_2'\rangle = \langle y_1|x_2\rangle + \alpha \langle y_1|y_1\rangle$$

$$0 = \langle y_1|x_2\rangle + \alpha \cdot 1$$

$$\therefore \alpha = -\langle y_1|x_2\rangle$$

Substituting α in (2),

$$|y_2'\rangle = |x_2\rangle - \langle y_1|x_2\rangle |y_1\rangle \quad -(3)$$

$$|y_2\rangle = \frac{|y_2'\rangle}{\|y_2'\|} = \frac{1}{\|y_2'\|}\left\{|x_2\rangle - \langle y_1|x_2\rangle |y_1\rangle\right\}.$$

Let $$|y_3'\rangle = |x_3\rangle + \beta |y_2\rangle + \Gamma |y_1\rangle \quad -(4)$$

operating (4) with $\langle y_2|$

$$\langle y_2|y_3'\rangle = \langle y_2|x_3\rangle + \beta\langle y_2|y_2\rangle + \Gamma\langle y_2|y_1\rangle$$

$$0 = \langle y_2|x_3\rangle + \beta$$

$$\beta = -\langle y_2|x_3\rangle \quad -(5)$$

Operating (4) with $\langle y_1|$

$$\langle y_1|y_3'\rangle = \langle y_1|x_3\rangle + \beta\langle y_1|y_2\rangle + \Gamma\langle y_1|y_1\rangle$$

$$0 = \langle y_1|x_3\rangle + \Gamma \cdot 1$$

$$\Gamma = -\langle y_1|x_3\rangle \quad -(6)$$

Sub β, Γ in (4),

$$|y_3'\rangle = |x_3\rangle - \langle y_2|x_3\rangle|y_2\rangle - \langle y_1|x_3\rangle|y_1\rangle$$

$$y_3 = \frac{|y_3'\rangle}{\|y_3'\|} = \frac{1}{\|y_3'\|}\left\{|x_3\rangle - \langle y_2|x_3\rangle|y_2\rangle - \langle y_1|x_3\rangle|y_1\rangle\right\}$$

In general,

$$y_n = \frac{1}{\|y_n'\|}\left\{|x_n\rangle - \langle y_{n-1}|x_n\rangle|y_{n-1}\rangle - \langle y_{n-2}|x_n\rangle|y_{n-2}\rangle - \cdots - \langle y_1|x_n\rangle|y_1\rangle\right\}$$

Example.

Let $|x_1\rangle = \begin{pmatrix}1\\0\end{pmatrix}$ $|x_2\rangle = \begin{pmatrix}0\\1\end{pmatrix}$

$$\langle x_1|x_1\rangle = (1\ 0)\begin{pmatrix}1\\0\end{pmatrix} = 1$$

$$\langle x_1|x_2\rangle = (1\ 0)\begin{pmatrix}0\\1\end{pmatrix} =$$

Let $|x_1\rangle = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$ $|x_2\rangle = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$

$\langle x_1|x_1\rangle = (1\ 0)\begin{pmatrix} 1 \\ 0 \end{pmatrix} = 1$ //.

$\langle x_1|x_2\rangle = (1\ 0)\begin{pmatrix} 1 \\ 1 \end{pmatrix} = 1$ //

$\therefore \langle x_1|, \langle x_2|$ are not orthonormal vectors;

Let $|y_1\rangle = \dfrac{|x_1\rangle}{\|x_1\|} = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$

$y_2 = \dfrac{1}{\|y_2'\|}\left\{|x_2\rangle - \langle y_1|x_2\rangle |y_1\rangle\right\}$

$\langle y_1|x_2\rangle = (1\ 0)\begin{pmatrix} 1 \\ 1 \end{pmatrix} = 1$

$\therefore y_2 = \begin{pmatrix} 1 \\ 1 \end{pmatrix} - \begin{pmatrix} 1 \\ 0 \end{pmatrix} = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$

$\langle y_1|y_1\rangle = (1\ 0)\begin{pmatrix} 1 \\ 0 \end{pmatrix} = 1$ //

$\langle y_1|y_2\rangle = (1\ 0)\begin{pmatrix} 0 \\ 1 \end{pmatrix} = 0$ //

$\therefore$ These are orthonormal vectors.

12. The metric tensor in spherical polar coordinates is,

$$ds^2 = dr^2 + r^2 d\theta^2 + r^2 \sin^2\theta \, d\phi^2$$

The metric tensor is given by,

$$ds^2 = g_{\alpha\beta} \, dx^\alpha dx^\beta$$

comparing with standard equation, the components of fundamental covariant metric is given by,

$$g_{11} = 1 \;, \quad g_{22} = r^2 \;, \quad g_{33} = r^2 \sin^2\theta$$

$$g_{\alpha\beta} = 0 \;, \quad \alpha \neq \beta$$

∴ The covariant fundamental metric tensor is given by,

$$g_{\alpha\beta} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & r^2 & 0 \\ 0 & 0 & r^2 \sin^2\theta \end{pmatrix}$$

Contravariant fundamental metric tensor is,

$$g^{\alpha\beta} = \frac{\text{Cofactor } g_{\alpha\beta}}{|g_{\alpha\beta}|} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1/r^2 & 0 \\ 0 & 0 & 1/r^2 \sin^2\theta \end{pmatrix}$$

Crystoffell symbols of first kind

$$\Gamma_{\mu\nu,\sigma} = \frac{1}{2}\left(\frac{\partial g_{\mu\sigma}}{\partial x^\nu} + \frac{\partial g_{\nu\sigma}}{\partial x^\mu} - \frac{\partial g_{\mu\nu}}{\partial x^\sigma}\right)$$

$$\Gamma_{11,1} = \frac{1}{2}\left(\frac{\partial g_{11}}{\partial x^1} + \frac{\partial g_{11}}{\partial x^1} - \frac{\partial g_{11}}{\partial x^1}\right)$$

$g_{11} = 1$

$x^1 = r$, $x^2 = \theta$, $x^3 = \phi$

$\therefore \quad \frac{\partial g_{11}}{\partial r} = \frac{\partial (1)}{\partial r} = 0.$

$\therefore \quad \Gamma_{11,1} = 0.$

$\Gamma_{22,2} = \frac{1}{2}\left(\frac{\partial g_{22}}{\partial \theta} + \frac{\partial g_{22}}{\partial \theta} - \frac{\partial g_{22}}{\partial \theta}\right)$

$g_{22} = r^2$

$\therefore \quad \Gamma_{22,2} = 0.$

Similarly, $\Gamma_{33,3} = 0.$

$\Gamma_{22,1} = \frac{1}{2}\left(\frac{\partial g_{21}}{\partial x^2} + \frac{\partial g_{21}}{\partial x^2} - \frac{\partial g_{22}}{\partial x^1}\right)$

$= \frac{1}{2}\left(0 + 0 - \frac{\partial (r^2)}{\partial r}\right) = \underline{\underline{-r}}.$

$\Gamma_{33,1} = \frac{1}{2}\left(\frac{\partial g_{31}}{\partial x^3} + \frac{\partial g_{31}}{\partial x^3} - \frac{\partial g_{33}}{\partial x^1}\right)$

$= \frac{1}{2}\left(0 + 0 - \frac{\partial (r^2 \sin^2\theta)}{\partial r}\right) = \underline{\underline{r \sin^2\theta}}.$

$\Gamma_{12,3} = \frac{1}{2}\left(\frac{\partial g_{13}}{\partial x^2} + \frac{\partial g_{23}}{\partial x^1} - \frac{\partial g_{12}}{\partial x^3}\right) = 0.$

$\therefore \quad \Gamma_{123} = \Gamma_{213} = \Gamma_{321} = \Gamma_{231} = 0.$

$\Gamma_{12,1} = \frac{1}{2}\left(\frac{\partial g_{11}}{\partial x^2} + \frac{\partial g_{21}}{\partial x^1} - \frac{\partial g_{12}}{\partial x^1}\right)$

$= \frac{1}{2}\left(\frac{\partial (1)}{\partial \theta} + 0 - 0\right) = 0 //$

∴ The non vanishing terms are $\Gamma_{22,1}$ and $\Gamma_{33,1}$.

Crystofell's symbols of 2nd kind.

$$\Gamma^{\sigma}_{\mu\nu} = g^{\sigma\lambda}\,\Gamma_{\mu\nu,\lambda}$$

$$\Gamma^{1}_{11} = g^{11}\Gamma_{11,1} + g^{12}\Gamma_{11,2} + g^{13}\Gamma_{11,3} = 0.$$

$$\left.\begin{matrix}\\ \\ \\ \end{matrix}\right\}\Gamma_{11,1} = \Gamma_{11,2} = \Gamma_{11,3} = 0$$

similarly,

$$\Gamma^{1}_{12} = g^{11}\Gamma_{12,1} + g^{12}\Gamma_{12,2} + g^{13}\Gamma_{12,3}.$$

$$= 0 //$$

$$\therefore \left.\begin{matrix}\\ \\ \\ \end{matrix}\right\}\Gamma_{12,1} = \Gamma_{12,2} = \Gamma_{12,3} = 0$$

Hence all components of crystofell's symbols of 2nd kind are zero.

13. Let $\lambda_1, \lambda_2 \ldots \lambda_n$ be eigen values of a matrix A and $x_1, x_2 \ldots x_n$ be eigen vectors,

$$X_i = \begin{bmatrix} x_{1i} \\ x_{2i} \\ \vdots \\ x_{ni} \end{bmatrix} = X_{ij}$$

Let 'p' be a matrix formed by eigen vectors,

$$P = \begin{pmatrix} x_{11}, & x_{12}, & \cdots & x_{1n} \\ x_{21}, & x_{22}, & \cdots & x_{2n} \\ \vdots & & & \\ x_{n1}, & x_{n2}, & \cdots & x_{nn} \end{pmatrix}$$

'D' be a diagonal matrix formed of eigen values,

$$D = \begin{pmatrix} \lambda_1 & 0 & 0 & \cdots \\ 0 & \lambda_2 & \cdots & \\ 0 & 0 & \lambda_3 & \cdots \\ 0 & 0 & 0 & \cdots \lambda_n \end{pmatrix}$$

$$PD = \begin{pmatrix} \lambda_1 x_{11} & 0 & 0 & \cdots \\ 0 & \lambda_2 x_{22} & 0 & \cdots \\ 0 & 0 & \cdots & \lambda_3 x_{33} \end{pmatrix}$$

$$= A[x_1, x_2 \cdots x_n]$$

$$= AP.$$

Premultiplying with P^{-1}

$$P^{-1}PD = P^{-1}AP$$

$$D = \underline{P^{-1}AP.}$$

Thus P can be found such that $P^{-1}AP$ is a diagonal matrix. This is called diagonalization of a matrix.

14. $A = \begin{pmatrix} 3 & 2 & 1 \\ 2 & 3 & 1 \\ 1 & 1 & 4 \end{pmatrix}$

We have to find a matrix M s.t. $AM = I$

$$\begin{pmatrix} 3 & 2 & 1 \\ 2 & 3 & 1 \\ 1 & 1 & 4 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Dividing R_1 by 3, R_2 by 2 and R_3 by 1

$$\begin{pmatrix} 1 & 0.6666 & 0.3333 \\ 1 & 1.5 & 0.5 \\ 1 & 1 & 4 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} 0.3333 & 0 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Subtracting first and third row from 2nd.

$$\begin{pmatrix} 0 & 0.8334 & 0.1667 \\ 1 & 1.5 & 0.5 \\ 0 & 0.5 & -3.5 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} -0.3333 & 0.5 & 0 \\ 0 & 0.5 & 0 \\ 0 & 0.5 & -1 \end{pmatrix}$$

÷ & second row by 1.5

$$\begin{pmatrix} 0 & 0.8334 & 0.1667 \\ 0 & 1 & 0.3333 \\ 0 & 0.5 & -3.5 \end{pmatrix} \quad \text{and} \quad \begin{pmatrix} -0.3333 & 0.5 & 0 \\ 0 & 0.333 & 0 \\ 0 & 0.5 & -1 \end{pmatrix}$$

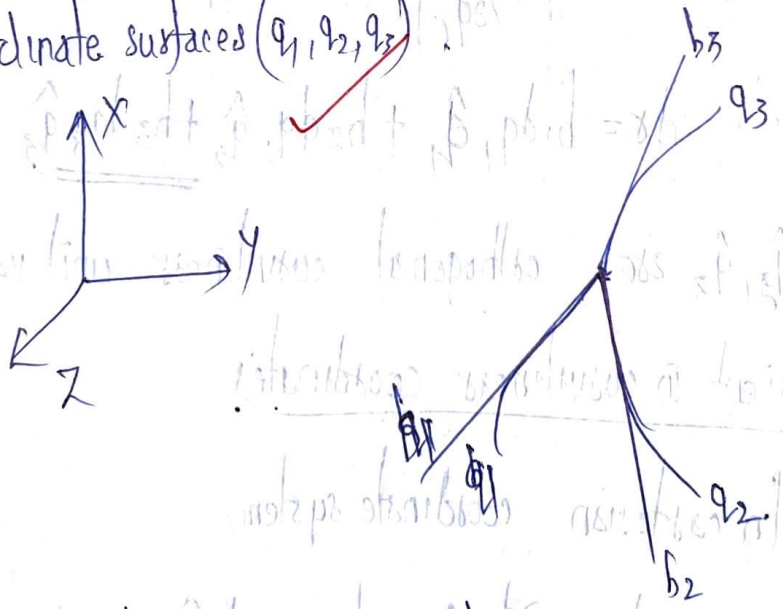
Sub R_1 changes to $R_1 - 0.8334R_2$ and $R_3 \to R_3 - 0.5R_2$.

$$\begin{pmatrix} 1 & 0.6666 & 0.3323 \\ 0 & 0.834 & 0.17 \\ 0 & 0.334 & 3.6 \end{pmatrix} \quad \begin{pmatrix} 0.333 & 0 & 1 \\ 0 & 0.5 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Part-C

15. The physical laws can be best expressed in terms of vectors. But the vectors need to be in appropriate coordinates before solving the physical problem. For example, a particle moving in a central force field has axial spherical symmetry, it can be represented by spherical polar coordinates and cylindrical polar coordinates can be used to describe a charged particle moving in a helical path having axial symmetry.

A point $P(x,y,z)$ is represented by intersection of 3 mutually perpendicular axes. Likewise in curvilinear coordinates, a point is represented by intersection of three mutually perpendicular coordinate surfaces (q_1, q_2, q_3).



The intersection of three mutually perpendicular curves is called coordinate lines and the tangents to which at the intersection gives the coordinate axes.

Element of displacement

Let $\vec{r}$ be a point defined as,

$$\vec{r} = r(q_1, q_2, q_3)$$

$$d\vec{r} = \frac{\partial r}{\partial q_1} dq_1 + \frac{\partial r}{\partial q_2} dq_2 + \frac{\partial r}{\partial q_3} dq_3$$

$$dr = b_1 dq_1 + b_2 dq_2 + b_3 dq_3 \quad \text{—(1)}$$

b_i is the base vector in the direction of change of r_i which depends on coordinates q_1, q_2, q_3.

A unit vector is defined as,

$$\hat{q}_i = \frac{\partial r / \partial q_i}{|\partial r_0 / \partial q_i|} = \frac{b_i}{|b_i|} = \frac{b_i}{h_i}$$

$$dr = h_1 dq_1 \hat{q}_1 + h_2 dq_2 \hat{q}_2 + h_3 dq_3 \hat{q}_3$$

$\hat{q}_1, \hat{q}_2, \hat{q}_3$ are orthogonal curvilinear unit vectors.

Gradient in curvilinear coordinates

In cartesian coordinate system,

$$\nabla \phi = \frac{\partial \phi}{\partial x} \hat{i} + \frac{\partial \phi}{\partial y} \hat{j} + \frac{\partial \phi}{\partial z} \hat{k}$$

In curvilinear coordinates,

$$\nabla \phi = \frac{\partial \phi}{h_1 \partial q_1} \hat{q}_1 + \frac{\partial \phi}{h_2 \partial q_2} \hat{q}_2 + \frac{\partial \phi}{h_3 \partial q_3} \hat{q}_3$$

$$\nabla = \frac{\partial}{h_1 \partial q_1}\hat{q}_1 + \frac{\partial}{h_2 \partial q_2}\hat{q}_2 + \frac{\partial}{h_3 \partial q_3}\hat{q}_3$$

Laplacean operator

$$\nabla^2\phi = \nabla\cdot(\nabla\phi)$$

Divergence in curvilinear coordinates

Applying Gauss divergence theorem,

$$\vec{A} = A_1\hat{i} + A_2\hat{j} + A_3\hat{k}$$

$$\int_V (\nabla\cdot A)\, dV = \int_S A\cdot ds \quad \text{---(1)}$$

Considering the contribution of surfaces perpendicular to q_1 to the surface integral,

$$(A_1\cdot ds)_{q_1+dq_1} - (A_1\cdot ds)_{q_1} = (A_1\cdot dr_2 dr_3)_{q_1+dq_1} - (A_1\, dr_2 dr_3)_{q_1}$$

$$= \frac{\partial}{\partial q_1}(A_1\, dr_2 dr_3)\, dq_1$$

$$= \frac{\partial}{\partial q_1}(A_1 h_2 h_3\, dq_2 dq_3 dq_1)$$

$$= \frac{1}{h_1 h_3}\frac{\partial}{\partial q_2}A_1\, dq_1 dq_2 dq_3$$

$$= \frac{\partial}{\partial q_2}\frac{1}{h_1 h_2 h_3 h_1}\frac{\partial}{\partial q_1}(A_1 h_2 h_3)\, dV$$

Comparing with L.H.S of (1),

$$\int (\nabla\cdot A_1)\, dV = \frac{1}{h_1 h_2 h_3}\frac{\partial}{\partial q_1}(A_1 h_2 h_3)$$

In general,

$$\nabla \cdot A = \frac{1}{h_1 h_2 h_3}\left\{\frac{\partial}{\partial q_1}(A_1 h_2 h_3) + \frac{\partial}{\partial q_2}(A_2 h_1 h_3) + \frac{\partial}{\partial q_3}(A_3 h_1 h_2)\right\}$$

→ Laplacean operator $\nabla^2\phi = \nabla\cdot(\nabla\phi)$.

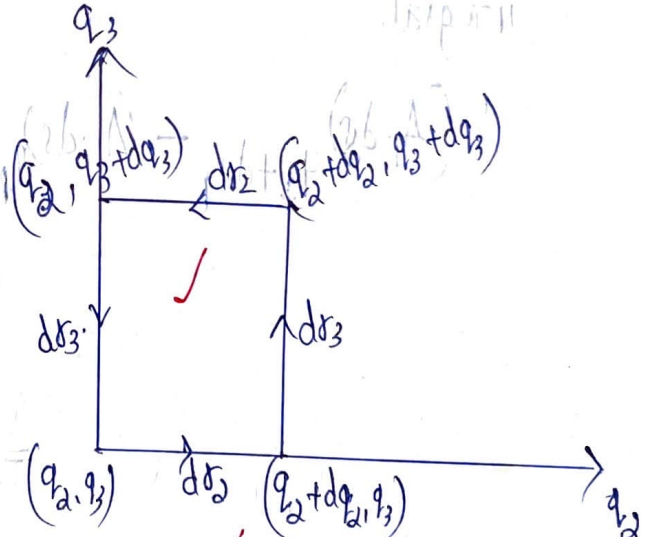
Curl in curvilinear coordinates

Applying stokes theorem,

$$\int_S (\nabla \times A)\, ds = \oint A \cdot dr \quad \text{— (2)}$$

Let $\vec{A} = A_1\hat{i} + A_2\hat{j} + A_3\hat{k}$

consider a loop.



$$\oint A\cdot dr = (A_2\, dr_2)_{q_3} + (A_3\, dr_3)_{q_2+dq_2} - (A_2 dr_2)_{q_3+dq_3} - (A_3 dr_3)_{q_2}$$

$$= (A_3\, dr_3)_{q_2+dq_2} - (A_3 dr_3)_{q_2} - \{(A_2 dr_2)_{q_3+dq_3} - (A_2 dr_2)_{q_3}\}$$

$$= \frac{\partial}{\partial q_2}(A_3 dr_3)\, dq_2 - \frac{\partial}{\partial q_3}(A_2 dr_2)\, dq_3$$

$$= \frac{\partial}{\partial q_2}(A_3 h_3\, dq_2 dq_3) - \frac{\partial}{\partial q_3}(A_2 dq_2 h_2\, dq_3)$$

$$= \left(\frac{\partial}{\partial q_2}(A_3 h_3) - \frac{\partial}{\partial q_3}(A_2 h_2)\right) dq_2 dq_3$$

$$\therefore (\nabla \times A_1)\, dS = (\nabla \times A_1)\, dx_2\, dx_3$$

$$= (\nabla \times A_1)\, h_2 dq_2\, h_3 dq_3.$$

$$\therefore \oint_S (\nabla \times A_1) dS = \frac{1}{h_2 h_3} \left\{ \frac{\partial}{\partial q_2}(A_3 h_3) - \frac{\partial}{\partial q_3}(A_2 h_2) \right\}$$

$$= \frac{h_1}{h_1 h_2 h_3} \left(\frac{\partial}{\partial q_2}(A_3 h_3) - \frac{\partial}{\partial q_3} A_2 h_2 \right)$$

It can be written as,

$$\nabla \times A = \begin{vmatrix} \hat{q}_1 & \hat{q}_2 & \hat{q}_3 \\ \frac{\partial}{\partial q_1} & \frac{\partial}{\partial q_2} & \frac{\partial}{\partial q_3} \\ A_1 h_1 & A_2 h_2 & A_3 h_3 \end{vmatrix}$$

16. Covariant differentiation of covariant vector

Let $A_p^{\prime}$ be transformed into $\bar{A}_\mu$

$$\bar{A}_\mu = \frac{\partial x^p}{\partial \bar{x}^\mu} A_p.$$

Differentiating w.r.t $\bar{x}^\nu$

$$\frac{\partial \bar{A}_\mu}{\partial \bar{x}^\nu} = \frac{\partial}{\partial \bar{x}^\nu}\left(\frac{\partial x^p}{\partial \bar{x}^\mu} A_p\right) = \frac{\partial x^p}{\partial \bar{x}^\mu} \frac{\partial A_p}{\partial \bar{x}^\nu} + \frac{\partial^2 x^p}{\partial \bar{x}^\nu \partial \bar{x}^\mu} A_p.$$

$$= \frac{\partial x^p}{\partial \bar{x}^\mu} \frac{\partial x^q}{\partial \bar{x}^\nu} \frac{\partial A_p}{\partial x^q} + \frac{\partial^2 x^p}{\partial \bar{x}^\mu \partial \bar{x}^\nu} A_p$$

The 2nd term on R.H.S suggests that the derivative $\frac{\partial \bar{A}_\mu}{\partial \bar{x}^\nu}$ do not transform like a tensor. We need those quantities obtained through partial differentiation and transform like tensor. For that we use,

$$\frac{\partial^2 x^\rho}{\partial \bar{x}^\mu \partial \bar{x}^\nu} = \frac{\partial x^\rho}{\partial \bar{x}^\lambda} \bar{\Gamma}^\lambda_{\mu\nu} - \frac{\partial x^\alpha}{\partial \bar{x}^\mu} \frac{\partial x^\beta}{\partial \bar{x}^\nu} \Gamma^\rho_{\alpha\beta}.$$

$$\frac{\partial \bar{A}_\mu}{\partial \bar{x}^\nu} = \frac{\partial x^\rho}{\partial \bar{x}^\mu} \frac{\partial x^q}{\partial \bar{x}^\nu} \frac{\partial A_\rho}{\partial x^q} + \left(\frac{\partial x^\rho}{\partial \bar{x}^\lambda} \bar{\Gamma}^\lambda_{\mu\nu} - \frac{\partial x^\alpha}{\partial \bar{x}^\mu} \frac{\partial x^\beta}{\partial \bar{x}^\nu} \Gamma^\rho_{\alpha\beta} \right) A_\rho.$$

$$= \frac{\partial x^\rho}{\partial \bar{x}^\mu} \frac{\partial x^q}{\partial \bar{x}^\nu} \frac{\partial A_\rho}{\partial x^q} + \bar{\Gamma}^\lambda_{\mu\nu} \bar{A}_\lambda - \frac{\partial x^\alpha}{\partial \bar{x}^\mu} \frac{\partial x^\beta}{\partial \bar{x}^\nu} \Gamma^\rho_{\alpha\beta} A_\rho.$$

$$\frac{\partial \bar{A}_\mu}{\partial \bar{x}^\nu} - \bar{\Gamma}^\lambda_{\mu\nu} \bar{A}_\lambda = \frac{\partial x^\rho}{\partial \bar{x}^\mu} \frac{\partial x^q}{\partial \bar{x}^\nu} \frac{\partial A_\rho}{\partial x^q} - \frac{\partial x^\alpha}{\partial \bar{x}^\mu} \frac{\partial x^\beta}{\partial \bar{x}^\nu} \Gamma^\rho_{\alpha\beta} A_\rho.$$

Interchanging dummy indices. $\rho = \alpha$, $q = \beta$. and resubstituting $\rho = \gamma$

$$\frac{\partial \bar{A}_\mu}{\partial \bar{x}^\nu} - \bar{\Gamma}^\lambda_{\mu\nu} \bar{A}_\lambda = \frac{\partial x^\alpha}{\partial \bar{x}^\mu} \frac{\partial x^\beta}{\partial \bar{x}^\nu} \left(\frac{\partial A_\gamma}{\partial x^\beta} - \Gamma^\gamma_{\alpha\beta} A_\gamma \right)$$

Introducing comma notation,

$$\frac{\partial \bar{A}_\mu}{\partial \bar{x}^\nu} - \bar{\Gamma}^\lambda_{\mu\nu} \bar{A}_\lambda = A_{\mu;\nu}$$

$$A_{\mu;\nu} = \frac{\partial x^\alpha}{\partial \bar{x}^\mu} \frac{\partial x^\beta}{\partial \bar{x}^\nu} (A_{\gamma;\beta}).$$

This transform like a tensor of rank 2, hence this is the covariant derivative of A of covariant vector.

Covariant differentiation of contravariant vector

Let A^α be transformed like,

$$\bar{A}^\mu = \frac{\partial \bar{x}^\mu}{\partial x^\alpha} A^\alpha.$$

Differentiating w.r.t $\bar{x}^\nu$

$$\frac{\partial \bar{A}^\mu}{\partial \bar{x}^\nu} = \frac{\partial}{\partial \bar{x}^\nu}\left(\frac{\partial \bar{x}^\mu}{\partial x^\alpha} A^\alpha\right)$$

$$= \frac{\partial}{\partial x^\beta}\left(\frac{\partial \bar{x}^\mu}{\partial x^\alpha} A^\alpha\right)\frac{\partial x^\beta}{\partial \bar{x}^\nu}$$

$$= \frac{\partial \bar{x}^\mu}{\partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\frac{\partial A^\alpha}{\partial x^\beta} + \frac{\partial^2 \bar{x}^\mu}{\partial x^\beta \partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu} A^\alpha.$$

The 2nd term on R.H.S shows that $\frac{\partial \bar{A}^\mu}{\partial \bar{x}^\nu}$ dont transform like a tensor. Hence we need to transform the derivative as tensor, We use,

$$\frac{\partial^2 x^\rho}{\partial \bar{x}^\mu \partial \bar{x}^\nu} = \frac{\partial x^\rho}{\partial \bar{x}^\lambda}\bar{\Gamma}^\lambda_{\mu\nu} - \frac{\partial x^\alpha}{\partial \bar{x}^\mu}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\Gamma^\rho_{\alpha\beta}$$

Interchanging x and $\bar{x}$ coordinates,

$$\frac{\partial^2 \bar{x}^\mu}{\partial x^\alpha \partial x^\beta} = \frac{\partial \bar{x}^\mu}{\partial \bar{x}^\gamma}\Gamma^\gamma_{\alpha\beta} - \frac{\partial \bar{x}^\sigma}{\partial x^\alpha}\frac{\partial \bar{x}^\lambda}{\partial x^\beta}\Gamma^\mu_{\sigma\lambda}$$

$$\therefore \frac{\partial \bar{A}^\mu}{\partial \bar{x}^\nu} = \frac{\partial \bar{x}^\mu}{\partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\frac{\partial A^\alpha}{\partial x^\beta} + \frac{\partial \bar{x}^\mu}{\partial x^\gamma}\Gamma^\gamma_{\alpha\beta}\frac{\partial x^\beta}{\partial \bar{x}^\nu}A^\alpha - \frac{\partial \bar{x}^\sigma}{\partial x^\alpha}\frac{\partial x^\lambda}{\partial \bar{x}^\sigma}\frac{\partial x^\beta}{\partial \bar{x}^\nu}A^\alpha.$$

$$\frac{\partial \bar{A}^\mu}{\partial \bar{x}^\nu} = \frac{\partial \bar{x}^\mu}{\partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\frac{\partial A^\alpha}{\partial x^\beta} + \frac{\partial \bar{x}^\mu}{\partial x^\gamma}\Gamma^\gamma_{\alpha\beta}\frac{\partial x^\beta}{\partial \bar{x}^\nu}A^\alpha - \frac{\partial \bar{x}^\sigma}{\partial x^\alpha}\delta^\lambda_\nu A^\alpha.$$

$$= \frac{\partial \bar{x}^\mu}{\partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\frac{\partial A^\alpha}{\partial x^\beta} + \frac{\partial \bar{x}^\mu}{\partial x^\gamma}\Gamma^\gamma_{\alpha\beta}\frac{\partial x^\beta}{\partial \bar{x}^\nu}A^\alpha - \frac{\partial \bar{x}^\sigma}{\partial x^\alpha}A^\alpha.$$

$$= \frac{\partial \bar{x}^\mu}{\partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\frac{\partial A^\alpha}{\partial x^\beta} + \frac{\partial \bar{x}^\mu}{\partial x^\mu}\Gamma^\mu_{\alpha\beta}\frac{\partial x^\beta}{\partial \bar{x}^\nu}A^\alpha - \bar{A}^\sigma$$

$$\frac{\partial \bar{A}^\mu}{\partial \bar{x}^\nu} - \Gamma^{\bar{\alpha}}_{\gamma\beta}\bar{A}^\sigma = \frac{\partial \bar{x}^\mu}{\partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\left(\frac{\partial A^\alpha}{\partial x^\beta} - \Gamma^\alpha_{\gamma\beta}A^\alpha\right)$$

$$\bar{A}_{\mu;\nu} = \frac{\partial \bar{A}^\mu}{\partial \bar{x}^\nu} - \Gamma^\alpha_{\gamma\beta}\bar{A}^\sigma$$

$$\therefore \bar{A}_{\mu;\nu} = \frac{\partial \bar{x}^\mu}{\partial x^\alpha}\frac{\partial x^\beta}{\partial \bar{x}^\nu}\left(A_{\alpha;\beta}\right).$$

This transform like a tensor of rank two, hence this is covariant derivative of $\bar{A}^\mu$ w.r.t $\bar{x}^\nu$.

INTERNAL MARKLISTS
2020-2021

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) - CSS (2019 admission)

CENTRE No: 14/E020

PROGRAMME: M.Sc. Mathematics

Name of the College: ST.THOMAS COLLEGE, PALAI

Sl. No.	Reg. No.	Name of the Candidate	ME010201 : Advanced Abstract Algebra		ME010202: Advanced Topology		ME010203: Numerical Solution with Python		ME010204: Complex Analysis		ME010205: Measure and Integration		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011015357	ADHEENA VIJAYAKUMAR	5	A+	5	A+	5	A+	5	A+	5	A+	
2	190011015358	ALNA JAMES	5	A+	4.8	A+	4.8	A+	5	A+	5	A+	
3	190011015359	ALPHONSA SHAJI	5	A+	5	A+	5	A+	5	A+	5	A+	
4	190011015360	AMRUTHA GOPALAKRISHNAN	5	A+	5	A+	5	A+	5	A+	5	A+	
5	190011015361	ANJU FRANCIS	5	A+	5	A+	5	A+	5	A+	5	A+	
6	190011015362	ANNET GEORGE	5	A+	4.8	A+	5	A+	5	A+	4.8	A+	
7	190011015363	CAROLINE THERESE	4.8	A+	4.8	A+	5	A+	4.8	A+	4.8	A+	
8	190011015364	DIMPLE T THENGUMPALLIL	5	A+	5	A+	5	A+	5	A+	5	A+	
9	190011015365	HARIPRIYA J	5	A+	5	A+	5	A+	5	A+	5	A+	
10	190011015366	LINTA JOSEPH	4.8	A+	4.8	A+	5	A+	4.8	A+	4.8	A+	
11	190011015367	MAGGI THOMAS	4.8	A+	4.8	A+	5	A+	4.8	A+	4.8	A+	
12	190011015368	MARIA GEO	5	A+	5	A+	5	A+	5	A+	5	A+	
13	190011015369	MARIET GRACE	5	A+	5	A+	5	A+	5	A+	5	A+	
14	190011015370	SEENU THOMAS	5	A+	5	A+	5	A+	5	A+	5	A+	
15	190011015371	SHARON ROSE BENNY	4.8	A+	4.8	A+	4.8	A+	4.8	A+	4.8	A+	
16	190011015372	SHERIN SEBASTIAN	5	A+	5	A+	5	A+	5	A+	5	A+	
17	190011015373	SHILPA ELIZABETH JOYCHEN	5	A+	5	A+	5	A+	5	A+	5	A+	
18	190011015374	SOORYA S S	4.8	A+	4.8	A+	4.8	A+	4.8	A+	4.8	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission.

2. These assessments were published and no grievances were from the students are pending.

Dr. Raj Mathew

Name & Signature of the TEACHER-IN- CHARGE

(College Seal)

Thankachan

Name & Signature of the HEAD OF THE DEPARTMENT

Thankachan Augustine

Dr. James John
Principal I/C
St. Thomas College, Palai

Name & Signature of the PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) - CSS (2019 admission)

CENTRE No: **14/E020**

PROGRAMME: **M.Sc. Statistics**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	ST500201: Estimation Theory		ST500202: Stochastic Processes		ST500203: Multivariate Distributions		ST010201: Advanced Probability Theory		ST010202: Statistical Computing II Using R		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	GPA	GPA	GPA	GPA	GPA	GPA	Grade	GPA	Grade	
1	190011020436	AKHITHA SASI	4.2	4.4	4.4	4.2	4.6	4.6	4.4	A	4.6	A+	
2	190011020437	ALIGA BASTIN	4.2	4.2	4.4	4	4.6	4.6	4.2	A	4.6	A+	
3	190011020438	AMRUTHENDU M	4.8	4.6	5	4.6	5	5	4.6	A+	5	A+	
4	190011020439	ANAGHA BABY	5	4.8	5	4.8	5	5	4.8	A+	5	A+	
5	190011020440	ANANDALEKSHMI K S	5	5	5	5	5	5	5	A+	5	A+	
6	190011020441	ANJU MARY KURIAN	5	5	5	5	5	5	5	A+	5	A+	
7	190011020442	APARNA S	4.2	4.2	4.4	4	4.6	4.6	4.2	A	4.6	A+	
8	190011020443	ATHIRA K R	4.4	4.2	4.4	4.2	4.6	4.6	4.2	A	4.6	A+	
9	190011020444	ATHIRA K S	4.8	4.8	5	4.6	5	5	4.8	A+	5	A+	
10	190011020445	JUSTIN GEORGE	4.8	4.8	4.8	4.8	5	5	4.8	A+	5	A+	
11	190011020446	LITTY DEVACHEN	5	5	5	5	5	5	5	A+	5	A+	
12	190011020447	MINNU ELIZABETH JOE	4.6	4.6	4.6	4.6	4.8	4.8	4.6	A+	4.8	A+	
13	190011020448	PRIYAMKA M	4.2	4	4.2	4	4.6	4.6	4	A	4.6	A+	
14	190011020449	RIVAN JOSE	4.4	4.2	4.4	4.2	4.8	4.8	4.2	A	4.8	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission

2. These assessments were published and no grievances were from the students are pending

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, P a l a i

Name & Signature of the
PRINCIPAL

Mahatma Gandhi University
KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com)-CSS (2019 admission)

CENTRE No: **14/E020**

PROGRAMME: **M.Sc. Physics**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	PH010201 Mathematical Methods in Physics - II		PH010202 Quantum Mechanics -I		PH010203 Statistical Mechanics		PH010204 Condensed Matter Physics		PH0101P General Physics Practicals		PH0102P Electronics Practicals		Remarks
			Theory		Theory		Theory		Theory		Practical		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011018777	ABHIRAMI V.T	5.0	A^+	4.8	A+	5.0	A+	5.0	A+	5.0	A^+	5.0	A^+	
2	190011018778	AKHILA BENNY	4.6	A^+	4.8	A+	4.8	A+	4.8	A+	5.0	A^+	5.0	A^+	
3	190011018779	AKHILA SUDHAKAR	4.8	A^+	4.6	A+	4.6	A+	4.6	A+	5.0	A^+	5.0	A^+	
4	190011018780	ALEENA JOSE	4.4	A	4.4	A	4.8	A+	4.6	A+	4.8	A^+	4.8	A^+	
5	190011018781	AMALA SHAJI	4.8	A^+	4.6	A+	4.4	A	4.8	A+	5.0	A^+	5.0	A^+	
6	190011018782	ANIT ALPHONSE PAULOSE	4.4	A	4.4	A	4.4	A	4.4	A	4.8	A^+	4.8	A^+	
7	190011018783	ANN SANDRA JOSEPH	4.6	A^+	4.8	A+	4.8	A+	4.6	A+	5.0	A^+	5.0	A^+	
8	190011018784	ASWATHY RAVEENDRAN	4.6	A^+	4.8	A+	4.8	A+	4.8	A+	5.0	A^+	5.0	A^+	
9	190011018785	DINTA SKARIA	4.8	A^+	4.8	A+	4.8	A+	4.8	A+	4.8	A^+	4.8	A^+	
10	190011018786	GOPIKA G NAIR	4.6	A^+	4.4	A	4.8	A+	4.8	A+	5.0	A^+	5.0	A^+	
11	190011018787	JERIN SUNNY	4.4	A	4.4	A	4.2	A	4.4	A	5.0	A+	5.0	A+	
12	190011018788	JISNA JAMES	5.0	A^+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	
13	190011018789	JOMAL GEORGE	4.6	A^+	4.6	A+	4.2	A	4.6	A+	4.8	A+	4.8	A+	
14	190011018790	MARIA THOMAS	4.8	A^+	5.0	A+	4.8	A+	5.0	A+	5.0	A+	5.0	A+	
15	190011018791	RAISA ALEX	5.0	A^+	5.0	A+	4.8	A+	5.0	A+	5.0	A+	5.0	A+	

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2. These assessments were published and no grievances were from the students are pending

Augustine J Edakkara

Name & Signature of the TEACHER-IN- CHARGE

(College Seal)

Dr. Ison V. Vanchipurackal
Head, Department of Physics
St. Thomas College, Palai
Arunapuram P.O, Pin-686 574, Kottayam Dist, Kerala
Mobile: 9447126265, E-mail: isonvp@rediffmail.com

Name & Signature of the HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai.

Name & Signature of the PRINCIPAL

PROGRAMME: **M.Sc. Physics**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	PH010201 Mathematical Methods in Physics - II		PH010202 Quantum Mechanics -I		PH010203 Statistical Mechanics		PH010204 Condensed Matter Physics		PH0101P General Physics Practicals		PH0102P Electronics Practicals		Remarks
			Theory		Theory		Theory		Theory		Practical		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
16	190011018792	RAVISANKAR K PEETHAMBARAN	4.4	A	4.6	A+	4.0	A	4.4	A	4.8	A+	4.8	A+	
17	190011018793	ROSE TERESE SHIBU	4.6	A^+	4.8	A+	4.8	A+	5.0	A+	5.0	A+	5.0	A+	
18	190011018794	SETHULAKSHMI SAJEEV	4.8	A^+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	
19	190011018795	SONA SOMAN	4.4	A	4.6	A+	4.4	A	4.6	A	4.8	A+	4.8	A+	
20	190011018796	SREELAKSHMI P M	4.6	A^+	4.6	A+	4.8	A+	4.8	A+	4.8	A+	4.8	A+	
21	190011018797	UNNIMAYA R	5.0	A^+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	
22	190011018798	URMILA RAO	5.0	A^+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	5.0	A+	

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Augustine J Edakkara

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. Ison V. Vanchipurackal
Head, Department of Physics
St. Thomas College, Palai
Arunapuram P.O., Kottayam Dist.,Kerala-686 574
Mobile:9446126926, Email: isonv@rediffmail.com

Dr. James John
Principal I/C
St. Thomas College, Palai

Name & Signature of the
PRINCIPAL

ST. THOMAS COLLEGE PALAI

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - FIRST SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M. Com)-CSS (2019 admission onwards)

CENTRE No: **14/E020**

PROGRAMME: **M.Sc. Chemistry**

Name of the College: **ST. THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	CH 50 02 01 Coordination Chemistry		CH 50 02 05 Inorganic Chemistry Practicals-I		CH 50 02 02 Organic Reaction Mechanism		CH 50 02 06 Organic Chemistry Practicals-I		CH 50 02 03 Chemical Bonding and Computational Chemistry		CH 50 02 06 Physical Chemistry Practicals-I		CH 50 20 04 Molecular Spectroscopy		Remarks
			Theory		Practical		Theory		Practical		Theory		Practical		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011010029	ANNITA EMMANUEL	4.20	A	4.60	A+	4.20	A	4.60	A+	4.20	A	4.60	A+	4.00	A	
2	190011010030	AKHILA ANILKUMAR	4.40	A	4.60	A+	4.60	A+	5.00	A+	4.20	A	4.60	A+	4.40	A	
3	190011010031	ALBY SEL	4.40	A	4.60	A+	4.60	A+	5.00	A+	4.20	A	4.60	A+	4.40	A	
4	190011010032	ALEENA ELIZABETH ALEX	4.60	A+	5.00	A+	4.60	A+	5.00	A+	4.60	A+	5.00	A+	4.60	A+	
5	190011010033	ALPHONSA K	4.80	A+	5.00	A+	4.80	A+	5.00	A+	4.80	A+	5.00	A+	4.40	A	
6	190011010034	ARCHANA MADHU	4.20	A	4.60	A+	4.40	A	4.60	A+	4.40	A	4.60	A+	4.40	A	
7	190011010035	ASHNA SANTHOSH	4.80	A+	5.00	A+	4.40	A	4.60	A+	4.60	A+	5.00	A+	4.80	A+	
8	190011010036	ATHIRA V S	4.40	A	4.60	A+	4.40	A	4.60	A+	4.00	A	4.60	A+	4.20	A	
9	190011010037	GANGA S NAIR	4.80	A+	5.00	A+	4.60	A+	5.00	A+	4.60	A+	5.00	A+	4.60	A+	
10	190011010038	GIYA MARTIN	4.00	A	4.60	A+	4.40	A	4.60	A+	4.00	A	4.60	A+	4.20	A	

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Amal Jose Baby

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Dr. SUNNY KURIAKOSE
Associate Professor & Head
Research & P.G. Dept. of Chemistry
St. Thomas College
Pala - 686 574, Kerala, India

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai

Name & Signature of the
PRINCIPAL

PROGRAMME: **M.Sc. Chemistry** Name of the College: **ST. THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Sl. No.	Reg. No.	Name of the Candidate	CH 50 02 01 Coordination Chemistry		CH 50 02 05 Inorganic Chemistry Practicals-I		CH 50 02 02 Organic Reaction Mechanism		CH 50 02 06 Organic Chemistry Practicals-I		CH 50 02 03 Chemical Bonding and Computational Chemistry		CH 50 02 06 Physical Chemistry Practicals-I		CH 50 20 04 Molecular Spectroscopy		Remarks
			Theory		Practical		Theory		Practical		Theory		Practical		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
11	190011010039	JYOTHILEKSHMI S	4.80	A+	5.00	A+	4.80	A+	5.00	A+	4.80	A+	5.00	A+	4.80	A+	
12	190011010040	LIZ TEENU MATHEWS	5.00	A+	5.00	A+	4.60	A+	5.00	A+	5.00	A+	5.00	A+	4.80	A+	
13	190011010041	MALU MATHEW	5.00	A+	5.00	A+	4.80	A+	5.00	A+	4.80	A+	5.00	A+	4.80	A+	
14	190011010042	MARIAT JAISON	4.60	A+	5.00	A+	4.40	A	4.60	A+	4.60	A+	5.00	A+	4.40	A	
15	190011010043	NITHYA R	4.40	A	4.60	A+	4.60	A+	5.00	A+	4.40	A	5.00	A+	4.20	A	
16	190011010044	RENCHU MATHEW	4.20	A	4.60	A+	4.40	A	4.60	A+	4.20	A	4.60	A+	4.20	A	
17	190011010045	ROMAL JOJO	4.20	A	4.60	A+	4.20	A	4.60	A+	4.20	A	4.60	A+	4.40	A	
18	190011010046	SNEHAMOL JOSE	4.00	A	4.60	A+	4.00	A	4.60	A+	4.00	A	4.60	A+	4.00	A	
19	190011010047	TONY MATHEW	4.00	A	4.60	A+	4.20	A	4.60	A+	4.00	A	4.60	A+	4.20	A	
20	190011009971	ROSMI REJI	4.00	A	4.60	A+	4.00	A	4.60	A+	4.00	A	4.60	A+	4.40	A	

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Amal Jose Baby

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TEACHER-IN- CHARGE

(College Seal)

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. SUNNY KURIAKOSE
Associate Professor & Head
Research & P.G. Dept. of Chemistry
St. Thomas College
Pala - 686 574, Kerala, India

Dr. James John
Principal I/C
St. Thomas College, Palai.

Name & Signature of the
PRINCIPAL

[Mahatma Gandhi University
KOTTAYAM – 686 560
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FORM B-SECONDSEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) -CSS (2019 admission)

CENTRE No: **14/E020**

PROGRAMME:**M.Sc. Botany** Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	BY010201 Plant Anatomy, Developmental Biology and Horticulture		BY010202 Cell Biology, Genetics and Plant Breeding		BY010203 Plant Physiology and Biochemistry		BY010204 Molecular Biology		BY010205 Plant Anatomy, Devlopmental Biology, Horticulture, Cell Biology, Genetics and Plant Breeding - Practical		BY010206 Plant Physiology, Biochemistry and Molecular Biology Practical		Remarks
			Theory		Theory		Theory		Theory		Practical		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011008849	ADITHYA SHAJI	5	A+	5	A+	5	A+	5	A+	5	A+	5	A+	
2	190011008850	ANANTHA KRISHNAN M	5	A+	5	A+	5	A+	5	A+	5	A+	5	A+	
3	190011008851	IRINE THERASA DIUS	5	A+	5	A+	5	A+	5	A+	5	A+	5	A+	
4	190011008852	JYOTHI JOSE	4	A+	4	A	4	A	3.6	A	4.6	A+	4.8	A+	
5	190011008853	KESIYAMOL BENCHAMIN	3.6	A	3.5	A	3.6	A	3.6	A	4	A	4.4	A	
6	190011008854	KRISHNANAND.H	4.8	A	4.8	A+	4.8	A+	4.6	A+	5	A+	5	A+	
7	190011008855	MANEESHA MANOJ	4.2	A	4.3	A	4.2	A	4.0	A	4.6	A+	4.6	A+	
8	190011008856	SANDRA ELSA CHACKO	4	A	3.8	A	4	A	3.8	A	4.2	A	4.4	A	
9	190011008857	SATHYA PRIYA M.	4.8	A+	4.8	A+	4.8	A+	4.8	A+	5	A+	5	A+	
10	190011008858	SNEHA THOMAS	4.8	A+	4.8	A+	4.8	A+	4.6	A+	4.6	A+	4.6	A+	
11	190011008859	SUMI ANDREWS	4.4	A	4.4	A	4.4	A	4.4	A	4.6	A+	4.6	A+	
12	190011008860	VISHNUPRIYA N.R	4.2	A	4.3	A	4.2	A	4.2	A	4.6	A+	4.6	A+	

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2. These assessments were published and no grievances were from the students are pending

Name & Signature of the TEACHER-IN- CHARGE

(College Seal)

Name & Signature of the HEAD OF THE DEPARTMENT

Name & Signature of the PRINCIPAL

Dr. James John
Principal I/C
St. Thomas C...

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) - CSS (2019 admission)

CENTRE No: **14/ E020**

PROGRAMME: **M.A. English**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	**EN010201: Modernity and Modernisms**		**EN010202: Postmodernism and Beyond**		**EN010203: American Literatures**		**EN010204:English Language History and Contemporary Linguistics**		**EN010205: Thinking Theory**		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011002118	AGNES ANDREWS	4.40	A	4.40	A	4.40	A	4.40	A	4.20	A	
2	190011002119	AKSHAI P SASI	4.80	A+	4.80	A+	4.60	A+	4.80	A+	4.80	A+	
3	190011002120	ALAN GEORGE	4.20	A	4.20	A	4.20	A	4.20	A	4.20	A	
4	190011002121	ALEX P LUKE	4.60	A+	4.80	A+	4.60	A+	4.80	A+	4.60	A+	
5	190011002122	ALKA MARIA SIMON	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
6	190011002123	ANAKHA ROSE JACOB	4.80	A+	4.80	A+	4.60	A+	4.80	A+	4.80	A+	
7	190011002124	ANILA MARIA JOSEPH	4.80	A+	4.80	A+	4.80	A+	4.60	A+	4.80	A+	
8	190011002125	ANJITHA M S	4.80	A+	4.60	A+	4.60	A+	4.80	A+	4.80	A+	
9	190011002126	APARNA RAJALAKSHMI	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
10	190011002127	CATHERINE BABY	5.00	A+	4.80	A+	5.00	A+	5.00	A+	4.80	A+	
11	190011002128	CHAITHANYA JOYSON	4.80	A+	4.80	A+	4.80	A+	4.80	A+	4.80	A+	
12	190011002129	DEEPAK JOHNS	4.60	A+	4.60	A+	4.80	A+	4.80	A+	4.80	A+	
13	190011002130	FREDY FRANCIS	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
14	190011002131	GOURI GAYATHRI G	5.00	A+	4.80	A+	5.00	A+	5.00	A+	4.80	A+	
15	190011002132	JUBLE LUCKSON	4.80	A+	4.60	A+	4.80	A+	4.60	A+	4.80	A+	

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2. These assessments were published and no grievances were from the students are pending

JOSE MATHEW
Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

RAJU K. AUGUSTINE
Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai.
Name & Signature of the
PRINCIPAL

PROGRAMME: **M.A. English** Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	**EN010201: Modernity and Modernisms**		**EN010202: Postmodernism and Beyond**		**EN010203: American Literatures**		**EN010204:English Language History and Contemporary Linguistics**		**EN010205: Thinking Theory**		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
16	190011002133	MANISHA C MATHEWS	4.20	A	4.20	A	4.20	A	4.40	A	4.20	A	
17	190011002134	MEENU SUNDARAN	4.40	A	4.40	A	4.20	A	4.40	A	4.40	A	
18	190011002135	MINU MATHEWS	4.80	A+	4.80	A+	4.60	A+	4.60	A+	5.00	A+	
19	190011002136	NEETHU P J	4.40	A	4.40	A	4.40	A	4.40	A	4.40	A	
20	190011002137	PEARLY S THOMAS	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
21	190011002138	PRASAD JOHNSON	4.80	A+	4.80	A+	5.00	A+	4.80	A+	4.60	A+	
22	190011002139	RAMYA ELIZABETH MATHEW	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
23	190011002140	ROSE MARY JAMES	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
24	190011002141	SANTHI M S	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
25	190011002142	SHEBY BABY	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
26	190011002143	SHEETHAL TRESA JOSEPH	-	-	-	-	-	-	-	-	-	-	
27	190011002144	SOUMYA KRISHNAN	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
28	190011002145	SUBIL RAJ	4.20	A	4.20	A	4.20	A	4.20	A	4.20	A	
29	190011002146	SUBITHA SUDHAKARAN	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
30	190011002147	TREESA THOMAS	4.80	A+	4.80	A+	5.00	A+	5.00	A+	4.80	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission
2. These assessments were published and no grievances were from the students are pending

JOSE MATHEW
Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

RAJU K. AUGUSTINE
Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai

Name & Signature of
PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com)-CSS (2019 admission onwards)

CENTRE No: **14/ E020**

PROGRAMME: **M.A. Malayalam**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	ML010201: Adhunikamalayala Kavitha: (Theory)		ML010202: Bhashasasthram (Theory)		ML010203: Keralasamskaram(Theory)		ML010204: Malayala Novel (Theory)		ML010205: Bharatheyasahithya sidhanthangal (Theory)		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011005746	ABHIJITH R NAIR	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
2	190011005747	ALVIN THANKACHAN	4.80	A+	4.80	A+	4.80	A+	4.80	A+	4.80	A+	
3	190011005748	AMALA TREESA JAMES	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
4	190011005749	ANISHA A MARIYA	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
5	190011005750	ANN ARDRA TOM	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
6	190011005751	CYRIL JOY	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
7	190011005752	DIAS FRANCIS	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
8	190011005753	GIGI GEORGE	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
9	190011005754	JINSHA JAYAN	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
10	190011005756	JOSNA T JOSEPH	4.80	A+	4.60	A+	4.60	A+	4.60	A+	4.60	A+	
11	190011005757	KEERTHI KUNJUMON	4.80	A+	4.80	A+	4.80	A+	4.80	A+	4.80	A+	
12	190011005758	NAYANA REVEENDRAN	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
13	190011005759	NAYANA THOMAS	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
14	190011005760	NEETHU BABY	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission
2. These assessments were published and no grievances were from the students are pending

Dr Thomas Scaria

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Davis

Name & Signature of the
HEAD OF THE DEPARTMENT

DR. DAVIS XAVIER
Head of the Dept. of Malayala
St. Thomas Colleg

ST. THOMAS COLLEGE PALAI

Dr. James John
Principal I/C
St Thomas College, Palai.

Name & Signature of the
PRINCIPAL

PROGRAMME: **M.A. Malayalam** Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	**ML010201: Adhunikamalayala Kavitha: (Theory**		**ML010202: Bhashasasthram (Theory**		**ML010203: Keralasamskaram(Theory)**		**ML010204: Malayala Novel (Theory)**		**ML010205: Bharatheyasahithya sidhanthangal (Theory)**		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
15	190011005761	NEETHUMOL P R	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
16	190011005762	STEFIN NARAYANAN N L	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
17	190011005763	TEEZAMOL SEBASTIAN	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
18	190011005764	TOMS RAJU	4.80	A+	4.60	A+	4.60	A+	4.60	A+	4.80	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission
2. These assessments were published and no grievances were from the students are pending

Dr Thomas Scaria

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Davis

Name & Signature of the
HEAD OF THE DEPARTMENT

DR. DAVIS XAVIER
Head of the Dept. of Malayalam
St. Thomas College, Pala

Dr. James John
Principal I/C
St. Thomas College, Palai.

Name & Signature of the
PRINCIPAL

ST. THOMAS COLLEGE PALAI

FORM A-1 (To be kept in the College)

MAHATMA GANDHI UNIVERSITY

INTERNAL ASSESSMENT (**Theory**) for P.G. PROGRAMME CSS (Effective from 2019 admissions)

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.A. Hindi Title: **HN010201 –History of Hindi Literature -II**

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
231	190011004785	ABHIRAMI. A.S	A+	A+	A	A	4.60	A+	
232	190011004786	AJITH SASI	A	A	A	A	4.00	A	
233	190011004787	AKSHAYA MADHUSOODANAN	A+	A+	A	A	4.60	A+	
234	190011004788	ANEESH V NAIR	A+	A+	A+	A+	5.00	A+	
235	190011004789	ARATHY MADHUSOODHANAN	A+	A+	A+	A+	5.00	A+	
236	190011004790	ASHA Y. S.	A+	A+	A+	A	4.80	A+	
237	190011004791	ASWATHY SAJEEV	A+	A+	A	A	4.60	A+	
238	190011004792	DEVIKA KRISHNAKUMAR	A+	A+	A	A	4.60	A+	
239	190011004793	GOWRI PRIYA P. J	A+	A+	A	A	4.60	A+	
240	190011004794	JINCY SARA IDICULLA	A+	A+	A	A	4.60	A+	
241	190011004795	KARTHIKA SATHEESH	A+	A+	A	A	4.60	A+	
242	190011004796	LAKSHMI MOHAN	A+	A+	A+	A+	5.00	A+	
243	190011004797	LITTY . P.TOMS	A	A	A	A	4.00	A	
244	190011004798	MAYA RAJAPPAN	A+	A+	A+	A+	5.00	A+	

Certified that : 1. The entries are verified with the records and there Ais no error or omission.
2. These assessments were published and no grievances from the students are pending.

Name & Signature of the Teacher(s) in charge

Anish C Isaac

Name & Signature of the Head of the Department

Dr. C K Jayaraj

(College Seal)

Name & Signature of the Principal

Dr. Thomas John
Principal
St. Thomas College, Palai

HN01020J

Programme: M.A. Hindi Title: **Paper ~~VIII~~ History of Hindi Literature II** Semester: **Second Semester**

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
245	190011004799	MILAN MARIA THOMAS	A+	A+	A+	A+	5.00	A+	
246	190011004800	SANGEETHA.P.S	A	A+	A	A	4.40	A	
247	190011004801	SHREE LAKSHMI S	A+	A+	A	A	4.60	A+	
248	190011004802	SOPHYA RAJ	A+	A+	A	A	4.60	A+	
249	190011004803	SRUTHIMOL M.K.	A	A+	A	A	4.40	A	
250	190011004804	SUDHY SURESH	A+	A+	A+	A+	5.00	A+	

Certified that : 1. The entries are verified with the records and there is no error or omission.
2. These assessments were published and no grievances from the students are pending.

Name & Signature of the Teacher(s) in charge

Anish Gyriac

Name & Signature of the Head of the Department

Dr C K James

(College Seal)

Name & Signature of the Principal

Dr. James John
Principal I/C
St. Thomas College, Palai.

Mahatma Gandhi University
KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B – SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) - CSS (2019 admission)

CENTRE No: **14/ E020**

PROGRAMME: **M.A. Economics**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	EC010201 **Microeconomics - II**		EC010202 **Macro Economics - II**		EC010203 Public Economics		EC010204 Indian Economy-II		EC010205 Statistical Methods for Economic Analysis		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011000589	AKSHAYA K M	3.60	B	4.20	A	3.80	B	3.40	B	4.20	A	
2	190011000590	ALBIN BINOY	4.80	A+	4.40	A	4.80	A+	4.60	A+	4.80	A+	
3	190011000591	ALEENA JOSEPH	4.20	A	4.40	A	4.00	A	4.20	A	4.60	A+	
4	190011000592	ANCILET RANI THOMAS	4.00	A	4.20	A	4.00	A	3.80	B	4.20	A	
5	190011000593	ANGELIN MARY GEORGE	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
6	190011000594	ANKITA TOMY	4.60	A+	4.60	A+	4.80	A+	5.00	A+	5.00	A+	
7	190011000595	ANMOL VARGHESE	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
8	190011000596	ANN MARY JOSE	4.60	A+	4.60	A+	4.60	A+	4.60	A+	4.80	A+	
9	190011000597	ANNU SUNNY	4.20	A	4.60	A+	4.40	A	4.40	A	4.60	A+	
10	190011000598	ANU MARIA JAISON	4.40	A	4.60	A+	4.60	A+	4.60	A+	4.60	A+	
11	190011000599	ASHAMOL V . G	3.80	B	4.40	A	4.00	A	3.60	B	4.20	A	
12	190011000600	CLAREES DOMINIC	4.00	A	4.40	A	4.00	A	3.20	B	4.40	A	
13	190011000601	DIYA SUSAN BABY	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
14	190011000602	DONIA MATHEW	4.40	A	4.40	A	4.20	A	4.80	A+	4.60	A+	
15	190011000603	FEBA ELIZABETH BIJU	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission
2. These assessments were published and no grievances were from the students are pending

JOJI JACOB

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Dr. BIJU K.C.

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. JAMES JOHN

Name & Signature of the
PRINCIPAL

PROGRAMME: **M.A. Economics** Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	EC010201 **Microeconomics - II**		EC010202 **Macro Economics - II**		EC010203 Public Economics		EC010204 Indian Economy-II		EC010205 Statistical Methods for Economic Analysis		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
16	190011000604	LIJO JOY	3.80	B	4.00	A	3.80	B	4.20	A	4.20	A	
17	190011000605	MATHU MATHEW	4.40	A	4.40	A	4.20	A	4.20	A	4.40	A	
18	190011000606	MEERA GOPI	3.60	B	4.20	A	3.80	B	3.20	B	4.20	A	
19	190011000607	MINNA MARY TOM	4.80	A+	4.40	A	4.80	A+	5.00	A+	5.00	A+	
20	190011000608	REKHA P. GEORGE	4.60	A+	4.00	A	4.40	A	4.60	A+	4.60	A+	
21	190011000609	REMYA JACOB	4.40	A	4.00	A	4.20	A	4.20	A	4.40	A	
22	190011000610	SAM NINAN	4.40	A	4.00	A	4.20	A	4.60	A+	4.40	A	
23	190011000611	SANDRA C JOSE	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
24	190011000612	SHELVIN THOMAS JACOB	4.60	A+	4.20	A	4.40	A	4.40	A	4.60	A+	
25	190011000613	SRUTHI M K	3.60	B	4.00	A	3.80	B	3.20	B	4.20	A	
26	190011000614	STELLA T .YOHANNAN	3.80	B	4.00	A	3.80	B	3.60	B	4.20	A	
27	190011000615	SUJITHRA. P. S	3.60	B	4.00	A	3.80	B	4.20	A	4.40	A	
28	190011000616	VISHNUPRIYA V . N.	4.80	A+	4.80	A+	5.00	A+	5.00	A+	5.00	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission
2. These assessments were published and no grievances were from the students are pending

JOJI JACOB
Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Dr. BIJU K.C.
Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. JAMES JOHN
Name & Signature of the
PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc. /M.Com)-CSS (2019 admission onwards)

CENTRE No: **14/E020**

PROGRAMME: **M.A. Politics**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	**PS010201: Political Sociology**		**PS010202: Western Political Thought: Modern Traditions**		**PS010203: Issues in Indian Politics**		**PS010204: Indian Administration**		**PS010205: Theoretical Foundations of International Relations**		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011006906	AJAL JAMES	5.00	A+	4.60	A+	5.00	A+	5.00	A+	5.00	A+	
2	190011006907	AKHIL SHAJI	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
3	190011006908	AKHILA GEORGE	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
4	190011006909	ALBIN P.S	4.40	A	3.60	B	4.40	A	4.40	A	4.60	A+	
5	190011006910	ANJALY ZACHARIAS	4.60	A+	4.60	A+	4.80	A+	4.80	A+	4.80	A+	
6	190011006911	ANJU.A	4.60	A+	3.60	B	4.60	A+	4.60	A+	4.20	A	
7	190011006912	ANU CYRIAC	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
8	190011006913	ARYA BABU	4.40	A	4.20	A	4.40	A	4.40	A	4.40	A	
9	190011006914	ASWATHY KRISHNA	5.00	A+	5.00	A+	5.00	A+	4.80	A+	5.00	A+	
10	190011006915	EDWIN JAISE	4.40	A	4.20	A	4.40	A	4.60	A+	4.40	A	
11	190011006916	GOPIKA ANIL	4.80	A+	4.60	A+	4.60	A+	5.00	A+	5.00	A+	
12	190011006917	GRACE MARY	4.80	A+	5.00	A+	4.80	A+	4.80	A+	4.80	A+	
13	190011006918	JERIN ANNIE GEORGE	4.60	A+	3.60	B	4.60	A+	4.60	A+	4.60	A+	
14	190011006919	JOSE TOM	4.40	A	3.60	B	4.40	A	4.40	A	4.60	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission

2. These assessments were published and no grievances were from the students are pending

Sijo K. Manuel
Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

For HOD
Dr. Stany Thomas
Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Name & Signature of the
PRINCIPAL

PROGRAMME: **M.A. Politics** Name of the College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Sl. No.	Reg. No.	Name of the Candidate	**PS010201: Political Sociology**		**PS010202: Western Political Thought: Modern Traditions**		**PS010203: Issues in Indian Politics**		**PS010204: Indian Administration**		**PS010205: Theoretical Foundations of International Relations**		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
15	190011006920	JUSTINE GEORGE	4.40	A	3.60	B	4.40	A	4.60	A+	4.60	A+	
16	190011006921	K K AIAPPADAS	4.60	A+	4.60	A+	4.60	A+	4.60	A+	4.60	A+	
17	190011006922	LEKSHMI BIJU	4.40	A	4.20	A	4.40	A	4.40	A	4.60	A+	
18	190011006923	LEKSHMI SREE KUMAR	5.00	A+	4.60	A+	5.00	A+	4.60	A+	5.00	A+	
19	190011006924	MELVIN MATHEW	4.80	A+	4.60	A+	5.00	A+	4.60	A+	4.60	A+	
20	190011006925	NAVYAMOL S	4.40	A	4.00	A	4.40	A	4.40	A	4.60	A+	
21	190011006926	PAUL MATHEW	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
22	190011006927	PRAVEENA PRATHAPAN	4.60	A+	4.00	A	4.40	A	4.40	A	4.60	A+	
23	190011006928	STEVE SAM BABU	4.60	A+	3.60	B	4.40	A	4.60	A+	4.60	A+	
24	190011006929	VISHNU VIJAYAN	4.40	A	3.60	B	4.40	A	4.40	A	4.40	A	
25	190011006847	GAHANA NAVYA JAMES	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission
2. These assessments were published and no grievances were from the students are pending

Sijo K. Manuel
Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

For HOD
Dr. Stany Thomas
Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Name & Signature of the
PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com)-CSS (2019 admission)

CENTRE No: **14/E020**

PROGRAMME: **M.A. History**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	HY010201: History of Social Institutions and Structures of Early India		HY010202: Social Formation of Kerala AD 1200-1800		HY010203: Debates on Medieval India		HY010204: Reflections on Women's History and Gender in Modern India		HY010205: India: The Making of a Colony		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011005049	ALEENA CHARLS	4.60	A+	4.60	A+	4.60	A+	4.60	A+	4.60	A+	
2	190011005050	ANU RAJU	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
3	190011005051	ARCHANA T S	4.00	A	3.60	B	4.00	A	4.00	A	4.00	A	
4	190011005052	ARDRA JAMES	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
5	190011005053	ASHLY SIBY	3.00	B	3.00	B	3.00	B	3.00	B	3.00	B	
6	190011005054	ASWATHY .T .SOMAN	3.60	B+	3.60	B+	3.60	B+	3.60	B+	3.60	B+	
7	190011005055	ASWIN VIJAYAN	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
8	190011005056	JIJIN M SUNNY	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
9	190011005057	JOPPY JOSE	3.60	B+	3.60	B+	3.60	B+	3.60	B+	3.60	B+	
10	190011005058	LIJOS MATHEW	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
11	190011005059	MARIA JOSE	4.60	A+	4.60	A+	4.60	A+	4.60	A+	4.60	A+	
12	190011005060	MINU V. T	3.20	B	3.20	B	3.20	B	3.20	B	3.20	B	

Certified that: 1. The entries are verified with the records and there is no error or omission.

2. These assessments were published and no grievances were from the students are pending.

MANESH VARGHESE JOHN
Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

MANESH VARGHESE JOHN
Name & Signature of the
HEAD OF THE DEPARTMENT

DR.JAMES JOHN
Name & Signature of the
PRINCIPAL

PROGRAMME: **M.A. History**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	**HY010201: History of Social Institutions and Structures of Early India**		**HY010202: Social Formation of Kerala AD 1200-1800**		**HY010203: Debates on Medieval India**		**HY010204: Reflections on Women's History and Gender in Modern India**		**HY010205: India: The Making of a Colony**		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
13	190011005061	ROSHAN BABU	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
14	190011005062	SUNU GEORGE	3.00	B	3.00	B	3.00	B	3.00	B	3.00	B	
15	190011005063	TOMCY TOM	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
16	190011005064	VISHNU V	4.60	A+	4.60	A+	4.60	A+	4.60	A+	4.60	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission.
2. These assessments were published and no grievances were from the students are pending.

MANESH VARGHESE JOHN
Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

MANESH VARGHESE JOHN
Name & Signature of the
HEAD OF THE DEPARTMENT

DR.JAMES JOHN
Name & Signature of the
PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M. Com) - CSS (2019 admission)

CENTRE No: **14/E020**

PROGRAMME: **M. Com Finance**

Name of the College: **ST. THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	CM010201: Advanced Corporate Accounting		CM010202: Human Resource Management		CM010203: International Business and Finance		CM010204: Quantitative Techniques		CM010205: Strategic Management		Remarks
			Theory		Theory		Theory		Theory		Theory		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011029202	ANITTA JOSEPH	4.60	A+	5.00	A+	4.80	A+	5.00	A+	5.00	A+	
2	190011029203	ANJALI J	4.80	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
3	190011029204	ANJALY NAIR	4.80	A+	5.00	A+	5.00	A+	4.80	A+	4.80	A+	
4	190011029205	ARATHY BABU	5.00	A+	5.00	A+	5.00	A+	4.80	A+	4.80	A+	
5	190011029206	DEVIKA S	4.80	A+	5.00	A+	4.80	A+	4.80	A+	4.80	A+	
6	190011029207	DIBI SEBASTIAN	-	-	-	-	-	-	-	-	-	-	
7	190011029208	DONA MARIA SEBASTIAN	4.60	A+	5.00	A+	4.80	A+	4.60	A+	4.80	A+	
8	190011029209	KRISHNA C DAMODAR	4.60	A+	5.00	A+	4.80	A+	4.60	A+	5.00	A+	
9	190011029210	MINNU MARIA JOSHY	4.60	A+	5.00	A+	5.00	A+	4.40	A	4.80	A+	
10	190011029211	NANDANA RAJAN	4.60	A+	4.60	A+	4.80	A+	3.80	A	4.40	A	
11	190011029212	NIKHIL THOMAS	4.60	A+	4.60	A+	4.80	A+	4.00	A	4.20	A	
12	190011029213	SANDRA ROSE BENNY	4.60	A+	5.00	A+	5.00	A+	4.80	A+	4.60	A+	
13	190011029214	SHERIN DOMINIC	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
14	190011029215	SNEHA JOSEPH	4.60	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	
15	190011029216	SREELAKSHMI K. R	4.60	A+	4.60	A+	4.80	A+	3.80	A	4.60	A+	
16	190011029217	TEENA VINCENT	4.60	A+	4.60	A+	4.80	A+	3.60	A	4.00	A	
17	190011029218	TERES M SAJI	5.00	A+	4.80	A+	5.00	A+	4.80	A+	4.60	A+	
18	190011029219	VISHNUPRIYA RAJAN	5.00	A+	5.00	A+	5.00	A+	5.00	A+	5.00	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission.
2. These assessments were published and no grievances were from the students are pending.

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai.

Name & Signature of the
PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) - CSS (2019 admission)

CENTRE No: **14/ E020**

PROGRAMME: **M.Sc. Biostatistics** Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	ST 02 0201: Matrix Algebra And Regression Analysis		ST02 0202 Sampling Distributions and Statistical Estimation Methods		ST 02 0203: Parametric And Non - Parametric Tests		ST02 0204 Epidemiology and Study Designs		ST02 0205 Statistical Data Analysis using SPSS, R and Python		Remarks
			Theory		Theory		Theory		Theory		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011008075	AMRUTHA SANKAR	3.87	B	4.00	A	4.02	A	3.50	B	3.57	B	
2	190011008076	ANEENA THANKACHAN	4.22	A	4.60	A+	4.18	A	4.25	A	4.11	A	
3	190011008077	ANEETTA SHAREN FERNANDEZ	3.65	B	4.33	A	3.94	B	3.80	B	3.78	B	
4	190011008078	ANGEL JOSE	4.02	A	4.46	A	4.32	A	4.16	A	3.93	B	
5	190011008079	ANN MARIYA MONCY	4.4	A	4.66	A+	4.16	A	4.08	A	4.03	A	
6	190011008080	ANNA MARIA REJU	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB	
7	190011008081	ANUJA R	3.58	B	4.20	A	4.3	A	3.90	B	3.80	B	
8	190011008082	BENSON BENNY	3.58	B	4.33	A	3.76	B	4.05	A	3.68	B	
9	190011008083	BRINIT CHACKO	4.42	A	4.46	A	4.3	A	4.30	A	4.02	A	
10	190011008084	CHINNU BABY	4.02	A	4.46	A	4.1	A	4.04	A	3.75	B	
11	190011008085	DEBIN SUNNY	4.06	A	4.60	A+	4.2	A	4.20	A	4.06	A	
12	190011008086	DONA THOMAS	4.24	A	4.66	A+	4.34	A	4.48	A	4.16	A	
13	190011008087	FAHEEMA T THAHA	3.13	B	4.00	A	3.74	B	3.78	B	3.73	B	
14	190011008088	KRISHNA S NAIR	4.41	A	4.60	A+	3.98	B	3.86	B	4.12	A	
15	190011008089	MALAVIKA B	3.92	B	4.46	A	4	A	4.12	A	3.90	B	
16	190011008090	PANCHAMI ANIL	4.22	A	4.60	A+	4.38	A	4.64	A+	4.04	A	

Certified that: 1. The entries are verified with the records and there is no error or omission

2. These assessments were published and no grievances were from the students are pending

Aneena · M·S

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

for, Meenu Tom Meenu

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal

Name & Signature of the
PRINCIPAL

PROGRAMME: **M.Sc. Biostatistics** Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	ST 02 0201: Matrix Algebra And Regression Analysis		ST02 0202 Sampling Distributions and Statistical Estimation Methods		ST 02 0203: Parametric And Non - Parametric Tests		ST02 0204 Epidemiology and Study Designs		ST02 0205 Statistical Data Analysis using SPSS, R and Python		Remarks
			Theory		Theory		Theory		Theory		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
17	190011008091	RADHIKA RAJAN	3.48	B	4.46	A	3.94	B	3.84	B	3.77	B	
18	190011008092	RENJU K R	3.66	B	4.20	A	4	A	3.55	B	3.67	B	
19	190011008093	ROOPA THOMAS	4.38	A	4.46	A	4.2	A	4.20	A	3.90	B	
20	190011008094	SHARON MATHEW P R	4.29	A	4.46	A	4.38	A	4.15	A	4.23	A	
21	190011008095	SREELAKSHMI M S	3.92	B	4.46	A	4.12	A	4.05	A	3.89	B	
22	190011008096	SREENUMOL BHASKARAN	3.84	B	4.26	A	4.02	A	3.80	B	3.79	B	

Certified that: 1. The entries are verified with the records and there is no error or omission
2. These assessments were published and no grievances were from the students are pending

Aneena. M.S

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Meenu

for, Meenu Tom

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai.

Name & Signature of the
PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) - CSS (2019 admission)

CENTRE No: **14/ E020**

PROGRAMME: **M.Sc. Biotechnology**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	BT020201 Microbiology		BT020202 Immunology		BT020203 Molecular Biology		BT020204 Enzymology and metabolism		BT020205 Laboratory Course - II		Remarks
			Theory		Theory		Theory		Theory		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011011506	AJO JOSE	4.00	A	4.00	A	3.60	B	4.00	A	4.60	A+	
2	190011011507	ASHA. S											
3	190011011508	ASHLY THERESE	4.00	A	3.40	B	3.20	B	4.00	A	4.20	A	
4	190011011509	ATHIRA PADMAKUMAR	3.60	B	3.80	B	3.80	B	3.60	B	4.20	A	
5	190011011510	BINCILY BABY	4.60	A+	4.20	A	4.20	A	4.60	A+	4.60	A+	
6	190011011511	CHRISTIN ALMA BIJU	4.20	A	3.60	B	4.80	A+	3.60	B	4.60	A+	
7	190011011512	DHANYA THOMAS	4.00	A	3.20	B	3.60	B	4.00	A	4.20	A	
8	190011011513	KARTHIKA SURESH	4.20	A	4.00	A	4.20	A	4.20	A	4.60	A+	
9	190011011514	KEERTHY KRISHNAN	3.80	B	3.60	B	3.00	B	3.60	B	4.20	A	
10	190011011515	NAYANA MURALI	4.20	A	3.40	B	4.60	A+	4.00	A	4.60	A+	
11	190011011516	NIMISHA SABU	3.60	B	3.00	B	3.20	B	3.60	B	4.20	A	
12	190011011517	RESHMA MURALI	4.60	A+	4.60	A+	4.60	A+	4.60	A+	4.60	A+	
13	190011011518	SILU SEBASTIAN	3.60	B	3.40	B	3.60	B	4.00	A	4.20	A	
14	190011011519	TOMBIN THOMAS	4.60	A+	4.40	A	4.20	A	4.00	A	4.60	A+	
15	190011011520	VRINDA MOHAN	4.20	A	3.20	B	4.00	A	3.60	B	4.60	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission

2. These assessments were published and no grievances were from the students are pending

Name & Signature of the TEACHER-IN- CHARGE

Jyothemol Joy

(College Seal)

Prof. JAMES JOSEPH
HEAD, DEPT. OF BIOTECHNOLOGY
APK College of Engineering
Arunapuram P. O
PALA - 686 574

Name & Signature of the HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai.

Name & Signature of the PRINCIPAL

Mahatma Gandhi University
KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B – SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com)-CSS (2019 admission)

CENTRE No: **14/ E020**

PROGRAMME: **M.Sc. Applied Microbiology**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	MG010201: Microbial Genetics & Molecular biology		MG010202: Environmental & Agricultural Microbiology		MG010203: Virology		MG010204: Immunology		MG010205: Laboratory Course II		Remarks
			Theory		Theory		Theory		Theory		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011008148	AAZMI SHIHAB	3.80	B	3.60	B	3.00	B	3.20	B	4.20	A	
2	190011008149	AJMIYA SIYAD	4.40	A	4.60	A+	4.20	A	4.00	A	4.20	A	
3	190011008150	ALPHONSA MATHEW	3.40	B	3.20	B	3.40	B	3.60	B	4.60	A+	
4	190011008151	ANGELA GEORGE	4.40	A	3.40	B	3.20	B	3.20	B	4.60	A+	
5	190011008152	ANU JOHN	3.40	B	4.20	A	3.40	B	3.60	B	4.20	A	
6	190011008153	ANUTTA TOMY	4.20	A	4.00	A	3.60	B	3.80	B	4.60	A+	
7	190011008154	ANUPAMA K THOMAS	4.00	A	4.20	A	3.80	B	3.40	B	4.60	A+	
8	190011008155	ASTHA S	4.20	A	3.20	B	3.40	B	3.20	B	4.20	A	
9	190011008156	ATHIRA .A	4.00	A	3.20	B	3.40	B	3.40	B	4.60	A+	
10	190011008157	ATHULYA SREEKUMAR	4.00	A	4.60	A+	4.60	A+	4.20	A	4.60	A+	
11	190011008158	DEVIKA M NAIR	4.60	A+	4.20	A	4.00	A	4.20	A	4.20	A	
12	190011008159	GOWRI SANKAR. J	4.60	A+	4.60	A+	4.20	A	4.60	A+	4.60	A+	
13	190011008160	KEERTHI SUDHARSANAN	4.00	A	4.20	A	4.60	A+	3.80	B	4.60	A+	
14	190011008161	KRISHNA PRASAD	4.40	A	4.00	A	4.00	A	3.80	B	4.20	A	
15	190011008162	MEERA KRISHNA	3.80	B	4.00	A	4.20	A	4.20	A	4.20	A	
16	190011008163	NAYANA K NAIR	4.00	A	3.40	B	3.60	B	4.00	A	4.60	A+	

Certified that: 1. The entries are verified with the records and there is no error or omission

2. These assessments were published and no grievances were from the students are pending

Priya Thomas

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C

Name & Signature of the
PRINCIPAL

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B – SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com)-CSS (2019 admission)

CENTRE No: **14/ E020**

PROGRAMME: **M.Sc. Applied Microbiology**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	MG010201: Microbial Genetics & Molecular biology		MG010202: Environmental & Agricultural Microbiology		MG010203: Virology		MG010204: Immunology		MG010205: Laboratory Course II		Remarks
			Theory		Theory		Theory		Theory		Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
17	190011008164	PARVATHY .S	4.40	A	3.40	B	3.20	B	3.60	B	4.20	A	
18	190011008165	RAJASHREE RAVI	4.00	A	4.00	A	4.00	A	4.20	A	4.60	A+	
19	190011008166	RESNI KHAN	4.40	A	4.60	A+	4.20	A	4.40	A	4.60	A+	
20	190011008167	SINDHYA MINNU. R	4.20	A	4.00	A	3.80	B	4.60	A+	4.60	A+	
21	190011008168	SOPHIA ELIZABETH VARGHESE	4.20	A	3.20	B	3.00	B	3.40	B	4.20	A	
22	190011008169	SREELAKSHMI H.	4.20	A	4.00	A	3.60	B	3.80	B	4.60	A+	
23	190011008170	VARSHA ELIZABETH JOSEPH	3.60	B	4.00	A	3.40	B	3.40	B	4.20	A	

Certified that: 1. The entries are verified with the records and there is no error or omission

2. These assessments were published and no grievances were from the students are pending

Priya Thomas

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

4/12/2020

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John
Principal I/C
St. Thomas College, Palai.

Name & Signature of the
PRINCIPAL

FORM A-1 (To be kept in the College)

MAHATMA GANDHI UNIVERSITY

INTERNAL ASSESSMENT (**Theory**) for P.G. PROGRAMME CSS (Effective from 2019 admissions)

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST 02 0201: Matrix Algebra And Regression Analysis

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
381	190011008075	AMRUTHA SANKAR	A	A	B	B	3.87	B	
382	190011008076	ANEENA THANKACHAN	A+	A	A	A	4.22	A	
383	190011008077	ANEETTA SHAREN FERNANDEZ	B	A	B	B	3.65	B	
384	190011008078	ANGEL JOSE	A	A	A	A	4.02	A	
385	190011008079	ANN MARIYA MONCY	A	A+	B	A	4.4	A	
387	190011008081	ANUJA R	A	B	B	A	3.58	B	
388	190011008082	BENSON BENNY	A	B	B	A	3.58	B	
389	190011008083	BRINIT CHACKO	A	A+	B	A	4.42	A	
390	190011008084	CHINNU BABY	A	A	A	A	4.02	A	
391	190011008085	DEBIN SUNNY	A	A	A	A	4.06	A	
393	190011008086	DONA THOMAS	A+	A	A	A	4.24	A	
394	190011008087	FAHEEMA T THAHA	B	B	B	B	3.13	B	
395	190011008088	KRISHNA S NAIR	A	A+	B	A	4.41	A	
396	190011008089	MALAVIKA B	A	A	B	B	3.92	B	

Certified that: 1. The entries are verified with the records and there is no error or omission.
2. These assessments were published and no grievances from the students are pending.

Aneena. M.S
Name & Signature of the Teacher(s) in charge

For,
Rose Maria Jose
Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST 02 0201: Matrix Algebra And Regression Analysis

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Gre	Grade	Weighted Grade Point	Overall Grade	
398	190011008090	PANCHAMI ANIL	A+	A	A	A	4.22	A	
399	190011008091	RADHIKA RAJAN	B	A	B	B	3.48	B	
400	190011008092	RENJU K R	B	A	B	B	3.66	B	
401	190011008093	ROOPA THOMAS	A	A+	B	A	4.38	A	
402	190011008094	SHARON MATHEW P R	A+	A	A	A	4.29	A	
403	190011008095	SREELAKSHMI M S	A	A	B	B	3.92	B	
405	190011008096	SREENUMOL BHASKARAN	A	A	B	B	3.84	B	

Certified that: 1. The entries are verified with the records and there is no error or omission.
2. These assessments were published and no grievances from the students are pending.

Aneena. M.S

Name & Signature of the Teacher(s) in charge

For Rose Maria Jose

Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

FORM A-1 (To be kept in the College)

MAHATMA GANDHI UNIVERSITY

INTERNAL ASSESSMENT (**Theory**) for P.G. PROGRAMME CSS (Effective from 2019 admissions)

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST02 0202 Sampling Distributions and Statistical Estimation Methods

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
381	190011008075	AMRUTHA SANKAR	A+	A	B	B	4.00	A	
382	190011008076	ANEENA THANKACHAN	A+	A	A+	A+	4.60	A+	
383	190011008077	ANEETTA SHAREN FERNANDEZ	A+	A	A	A	4.33	A	
384	190011008078	ANGEL JOSE	A+	A	A+	A+	4.46	A	
385	190011008079	ANN MARIYA MONCY	A	A+	A+	A+	4.66	A+	
387	190011008081	ANUJA R	A+	A	A	A	4.20	A	
388	190011008082	BENSON BENNY	A+	A	A	A	4.33	A	
389	190011008083	BRINIT CHACKO	A+	A	A+	A+	4.46	A	
390	190011008084	CHINNU BABY	A+	A	A+	A+	4.46	A	
391	190011008085	DEBIN SUNNY	A+	A	A+	A+	4.60	A+	
393	190011008086	DONA THOMAS	A	A+	A+	A+	4.66	A+	
394	190011008087	FAHEEMA T THAHA	A	A	A	A	4.00	A	
395	190011008088	KRISHNA S NAIR	A+	A	A+	A+	4.60	A+	
396	190011008089	MALAVIKA B	A+	A	A+	A+	4.46	A	

Certified that: 1. The entries are verified with the records and there is no error or omission.
2. These assessments were published and no grievances from the students are pending.

Aneena. M-S

Name & Signature of the Teacher(s) in charge

For Rose Maria Jose

Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST02 0202 Sampling Distributions and Statistical Estimation Methods

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
398	190011008090	PANCHAMI ANIL	A+	A	A+	A+	4.60	A+	
399	190011008091	RADHIKA RAJAN	A+	A	A+	A+	4.46	A	
400	190011008092	RENJU K R	A+	A	A	A	4.20	A	
401	190011008093	ROOPA THOMAS	A+	A	A+	A+	4.46	A	
402	190011008094	SHARON MATHEW P R	A+	A	A+	A+	4.46	A	
403	190011008095	SREELAKSHMI M S	A+	A	A+	A+	4.46	A	
405	190011008096	SREENUMOL BHASKARAN	A	A	A+	A+	4.26	A	

Certified that: 1. The entries are verified with the records and there is no error or omission.
2. These assessments were published and no grievances from the students are pending.

Aneena. M-S

Name & Signature of the Teacher(s) in charge

For Rose Maria Jose

Name & Signature of the Head of the Department

ST. THOMAS COLLEGE PALAI

(College Seal)

Name & Signature of the Principal

FORM A-1 (To be kept in the College)

MAHATMA GANDHI UNIVERSITY

INTERNAL ASSESSMENT (**Theory**) for P.G. PROGRAMME CSS (Effective from 2019 admissions)

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST 02 0203: Parametric And Non - Parametric Tests

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
381	190011008075	AMRUTHA SANKAR	A	A	A	A	4.02	A	
382	190011008076	ANEENA THANKACHAN	A	A	A+	A	4.18	A	
383	190011008077	ANEETTA SHAREN FERNANDEZ	A	A	B	B	3.94	B	
384	190011008078	ANGEL JOSE	A	A	A+	A+	4.32	A	
385	190011008079	ANN MARIYA MONCY	A	A	A	A+	4.16	A	
387	190011008081	ANUJA R	A	A	A+	A+	4.3	A	
388	190011008082	BENSON BENNY	A	A	C	A	3.76	B	
389	190011008083	BRINIT CHACKO	A	A	A+	A+	4.3	A	
390	190011008084	CHINNU BABY	A	A	A	A	4.1	A	
391	190011008085	DEBIN SUNNY	A	A	A+	A+	4.2	A	
393	190011008086	DONA THOMAS	A	A	A+	A+	4.34	A	
394	190011008087	FAHEEMA T THAHA	A	A	B	B	3.74	B	
395	190011008088	KRISHNA S NAIR	A	A	A	B	3.98	B	
396	190011008089	MALAVIKA B	A	A	A	A	4	A	

Certified that: 1. The entries are verified with the records and there is no error or omission.
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Aneena - M·S

Name & Signature of the Teacher(s) in charge

For Rose Maria Jose

Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST82 0203 Parametric And Non Parametric Tests

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
398	190011008090	PANCHAMI ANIL	A	A	A+	A+	4.38	A	
399	190011008091	RADHIKA RAJAN	A	A	A	B	3.94	B	
400	190011008092	RENJU K R	A	A	A	B	4	A	
401	190011008093	ROOPA THOMAS	A	A	A+	A	4.2	A	
402	190011008094	SHARON MATHEW P R	A	A	A+	A+	4.38	A	
403	190011008095	SREELAKSHMI M S	A	A	A	A	4.12	A	
405	190011008096	SREENUMOL BHASKARAN	A	A	A+	B	4.02	A	

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MAHATMA GANDHI UNIVERSITY

INTERNAL ASSESSMENT (**Theory**) for P.G. PROGRAMME CSS (Effective from 2019 admissions)

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST02 0204 Epidemiology and Study Designs

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
381	190011008075	AMRUTHA SANKAR	B	A	B	B	3.50	B	
382	190011008076	ANEENA THANKACHAN	A	A+	A	B	4.25	A	
383	190011008077	ANEETTA SHAREN FERNANDEZ	A	A	A	B	3.80	B	
384	190011008078	ANGEL JOSE	A	A	A+	B	4.16	A	
385	190011008079	ANN MARIYA MONCY	A	A	A+	B	4.08	A	
387	190011008081	ANUJA R	B	A	A+	B	3.90	B	
388	190011008082	BENSON BENNY	A	A	A+	B	4.05	A	
389	190011008083	BRINIT CHACKO	B	A+	A+	B	4.30	A	
390	190011008084	CHINNU BABY	A	A	A+	B	4.04	A	
391	190011008085	DEBIN SUNNY	A	A+	B	A	4.20	A	
393	190011008086	DONA THOMAS	A	A+	A+	B	4.48	A	
394	190011008087	FAHEEMA T THAHA	B	A	A	B	3.78	B	
395	190011008088	KRISHNA S NAIR	A	A	B	B	3.86	B	
396	190011008089	MALAVIKA B	A	A	A+	B	4.12	A	

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Aneena M.S

Name & Signature of the Teacher(s) in charge

For Rose Maria Jose

Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST02 0204 Epidemiology and Study Designs

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
398	190011008090	PANCHAMI ANIL	A	A+	A+	A	4.64	A+	
399	190011008091	RADHIKA RAJAN	B	A	A	A	3.84	B	
400	190011008092	RENJU K R	B	A	B	B	3.55	B	
401	190011008093	ROOPA THOMAS	A	A	A+	A	4.20	A	
402	190011008094	SHARON MATHEW P R	A	A	A+	B	4.15	A	
403	190011008095	SREELAKSHMI M S	A	A	A+	B	4.05	A	
405	190011008096	SREENUMOL BHASKARAN	B	A	A	A	3.80	B	

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For Rose Maria Jose

Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

FORM A-1 (To be kept in the College)

MAHATMA GANDHI UNIVERSITY

INTERNAL ASSESSMENT (**Theory**) for P.G. PROGRAMME CSS (Effective from 2019 admissions)

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST02 0205 Statistical Data Analysis using SPSS, R and Python

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
381	190011008075	AMRUTHA SANKAR	A	A	C	C	3.57	B	
382	190011008076	ANEENA THANKACHAN	A+	A	B	B	4.11	A	
383	190011008077	ANEETTA SHAREN FERNANDEZ	A	A	B	B	3.78	B	
384	190011008078	ANGEL JOSE	A	A	B	B	3.93	B	
385	190011008079	ANN MARIYA MONCY	A+	A	B	B	4.03	A	
387	190011008081	ANUJA R	A	A	B	B	3.80	B	
388	190011008082	BENSON BENNY	A	A	B	B	3.68	B	
389	190011008083	BRINIT CHACKO	A	A	A	A	4.02	A	
390	190011008084	CHINNU BABY	A	A	B	B	3.75	B	
391	190011008085	DEBIN SUNNY	A+	A	B	B	4.06	A	
393	190011008086	DONA THOMAS	A+	A	B	B	4.16	A	
394	190011008087	FAHEEMA T THAHA	A	A	B	B	3.73	B	
395	190011008088	KRISHNA S NAIR	A+	A	B	B	4.12	A	
396	190011008089	MALAVIKA B	A	A	B	B	3.90	B	

Certified that: 1. The entries are verified with the records and there is no error or omission.
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Aneena. M.S

Name & Signature of the Teacher(s) in charge

For Rose Maria Jose

Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

Centre No: **14/ E020** College: **ST.THOMAS COLLEGE, PALAI** Semester: **Second Semester**

Programme: M.Sc Biostatistics Title: ST02 0202 Sampling Distributions and Statistical Estimation Methods

Class No.	Reg. No.	Name of Candidate	Assignment (Wt.1)	Seminar (Wt. 2)	Test Paper 1 (Wt.1)	Test Paper 2 (Wt.1)	Consolidated		Remarks
			Grade	Grade	Grade	Grade	Weighted Grade Point	Overall Grade	
398	190011008090	PANCHAMI ANIL	A	A	A	A	4.04	A	
399	190011008091	RADHIKA RAJAN	A	A	B	B	3.77	B	
400	190011008092	RENJU K R	A	A	B	B	3.67	B	
401	190011008093	ROOPA THOMAS	A	A	B	B	3.90	B	
402	190011008094	SHARON MATHEW P R	A+	A	A	A	4.23	A	
403	190011008095	SREELAKSHMI M S	A	A	B	B	3.89	B	
405	190011008096	SREENUMOL BHASKARAN	A	A	B	B	3.79	B	

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Aneena. M.S

Name & Signature of the Teacher(s) in charge

For

Rose Maria Jose

Name & Signature of the Head of the Department

(College Seal)

Name & Signature of the Principal

Mahatma Gandhi University

KOTTAYAM – 686 560

(Established by Kerala State Legislature by Notification No. 3431/Leg. C1/85/Law dated 17th April 1985)

FORM B - SECOND SEMESTER INTERNAL EVALUATION FOR P.G. PROGRAMME (M.A./M.Sc./M.Com) - CSS (2019 admission)

CENTRE No: **14/ E020**

PROGRAMME: **M.Sc. Biostatistics**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	ST 02 0201: Matrix Algebra And Regression Analysis		ST02 0202 Sampling Distributions and Statistical Estimation Methods		ST 02 0203: Parametric And Non - Parametric Tests		ST02 0204 Epidemiology and Study Designs		ST02 0205 Statistical Data Analysis using SPSS, R and Python		Remarks
			Theory		Theory		Theory		Theory		Theory / Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
1	190011008075	AMRUTHA SANKAR	3.87	B	4.00	A	4.02	A	3.50	B	3.57	B	
2	190011008076	ANEENA THANKACHAN	4.22	A	4.60	A+	4.18	A	4.25	A	4.11	A	
3	190011008077	ANEETTA SHAREN FERNANDEZ	3.65	B	4.33	A	3.94	B	3.80	B	3.78	B	
4	190011008078	ANGEL JOSE	4.02	A	4.46	A	4.32	A	4.16	A	3.93	B	
5	190011008079	ANN MARIYA MONCY	4.4	A	4.66	A+	4.16	A	4.08	A	4.03	A	
6	190011008080	ANNA MARIA REJU	AB	AB	AB	AB	AB	AB	AB	AB	AB	AB	
7	190011008081	ANUJA R	3.58	B	4.20	A	4.3	A	3.90	B	3.80	B	
8	190011008082	BENSON BENNY	3.58	B	4.33	A	3.76	B	4.05	A	3.68	B	
9	190011008083	BRINIT CHACKO	4.42	A	4.46	A	4.3	A	4.30	A	4.02	A	
10	190011008084	CHINNU BABY	4.02	A	4.46	A	4.1	A	4.04	A	3.75	B	
11	190011008085	DEBIN SUNNY	4.06	A	4.60	A+	4.2	A	4.20	A	4.06	A	
12	190011008086	DONA THOMAS	4.24	A	4.66	A+	4.34	A	4.48	A	4.16	A	
13	190011008087	FAHEEMA T THAHA	3.13	B	4.00	A	3.74	B	3.78	B	3.73	B	
14	190011008088	KRISHNA S NAIR	4.41	A	4.60	A+	3.98	B	3.86	B	4.12	A	
15	190011008089	MALAVIKA B	3.92	B	4.46	A	4	A	4.12	A	3.90	B	
16	190011008090	PANCHAMI ANIL	4.22	A	4.60	A+	4.38	A	4.64	A+	4.04	A	

Certified that: 1. The entries are verified with the records and there is no error or omission

2. These assessments were published and no grievances were from the students are pending

Aneena. M.S

Name & Signature of the
TEACHER-IN- CHARGE

(College Seal)

for, Meenu Tom Meenu

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John

Name & Signature of the
PRINCIPAL

Principal I/C
St. Thomas College, Pala.

ROGRAMME: **M.Sc. Biostatistics**

Name of the College: **ST.THOMAS COLLEGE, PALAI**

Sl. No.	Reg. No.	Name of the Candidate	ST 02 0201: Matrix Algebra And Regression Analysis		ST02 0202 Sampling Distributions and Statistical Estimation Methods		ST 02 0203: Parametric And Non - Parametric Tests		ST02 0204 Epidemiology and Study Designs		ST02 0205 Statistical Data Analysis using SPSS, R and Python		Remarks
			Theory		Theory		Theory		Theory		Theory Practical		
			GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	GPA	Grade	
17	190011008091	RADHIKA RAJAN	3.48	B	4.46	A	3.94	B	3.84	B	3.77	B	
18	190011008092	RENJU K R	3.66	B	4.20	A	4	A	3.55	B	3.67	B	
19	190011008093	ROOPA THOMAS	4.38	A	4.46	A	4.2	A	4.20	A	3.90	B	
20	190011008094	SHARON MATHEW P R	4.29	A	4.46	A	4.38	A	4.15	A	4.23	A	
21	190011008095	SREELAKSHMI M S	3.92	B	4.46	A	4.12	A	4.05	A	3.89	B	
22	190011008096	SREENUMOL BHASKARAN	3.84	B	4.26	A	4.02	A	3.80	B	3.79	B	

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(College Seal)

for, Meenu Tom

Name & Signature of the
HEAD OF THE DEPARTMENT

Dr. James John

Name & Signature of the
PRINCIPAL I/C
Principal
St. Thomas College, Pala.

MODEL ASSIGNMENT
2020-2021

Name of the Student: Abhirami V.T.

Class Number: 51

Name of the Programme: M.Sc. Physics

Name of the Course: Quantum Mechanics - I

Date: 05. 07. 2020

ST. THOMAS COLLEGE, PALAI

C.B.C.S.S: ..... Programmes

ASSIGNMENT | SEMINAR / VIVA

Internal evaluation

Programme: M.Sc PHYSICS | Code: PH010202 | Semester: II

Name of the student: Abhirami V. T.

Class No.: 51 | Uni. Reg. No.: 190011018777

Topic: Quantum Mechanics - I

Assignment

Components	Grade awarded	Grade Point	Weight	WGP
Punctuality	A	4	1	4
Review	A	4	1	4
Content	A	4	2	8
Conclusion	A	4	1	4
References	A	4	1	4
Total		20	6	24

Seminar / Viva

Components	Grade awarded	Grade Point	Weight	WGP
Innovation			1	
Review/ reference			1	
Content			2	
Conclusion			1	
Presentation			1	
Total			6	

GPA = TotalWGP/6 = 4.0

GPA = Total WGP/6 = _____

Grade for Assignment = A

Grade for Seminar/Viva = _____

Grade, Grade points

GRADE	A	B	C	D	E
GRADE POINT	4	3	2	1	0

grade calculation

GPA	3.5 *to* 4	2.5 *to* 3.49	1.5 *to* 2.49	0.5 *to* 1.49	0 *to* 0.49
GRADE	A	B	C	D	E

Dr. Jobin Job Mathew

Name & Signature of the Class Teacher

Q.1

(a) Discuss the operators and properties in general for Q.M formulation.

(b) Describe the general uncertainty relation and further development in Q.M.

ans:- a) Observables like momentum and spin components are represented by operators which can act on kets. Let x, y, z are operators then

1. $(x)|\alpha\rangle = x|\alpha\rangle$; An operator acts on a ket from the left side. The resulting product is another ket.

2. operators x and y are said to be equal ie $x = y$ then we have,
$$x|\alpha\rangle = y|\alpha\rangle$$

(3) operators x is said to be the null operator if for any arbitrary ket $|\alpha\rangle$,
$$x|\alpha\rangle = 0.$$

(4) Operators can be added, addition operations are commutative and associative.
$$x + y = y + x$$
$$x + (y + z) = (x + y) + z.$$

(5) An operator x always acts on a bra from the right side,
$$\langle\alpha|(x) = \langle\alpha|x$$
and the resulting product is another bra.

(6) The ket $x|\alpha\rangle$ and the bra $\langle\alpha|x$ are in general not dual to each other. We define the symbol $x^\dagger$ as,

$$x|\alpha\rangle \xleftrightarrow{DC} \langle\alpha|x^\dagger$$

The operator $x^\dagger$ is called the Hermitian adjoint, or simply the adjoint of x. An operator x is said to be Hermitian if $x = x^\dagger$.

Multiplication

(i) Operators x and y can be multiplied but the multiplication operators are non-commutative.

i.e, $xy \neq yx$

(ii) But it obeys associative property,

$$x(yz) = (xy)z = xyz.$$

(iii) $xy|\alpha\rangle = x(y|\alpha\rangle) \xleftrightarrow{DC} (\langle\alpha|y^\dagger)x^\dagger = \langle\alpha|y^\dagger x^\dagger$

where, $(xy)^\dagger = y^\dagger x^\dagger$.

(iv) Let us multiply $|\beta\rangle$ and $\langle\alpha|$ in that order. The resulting product $(|\beta\rangle)\cdot(\langle\alpha|) = |\beta\rangle\langle\alpha|$ is known as the outerproduct of $|\beta\rangle$ and $\langle\alpha|$ also known as the projection operators. The outerproduct is regarded to be an operator.

Associative Axiom.

First consider an outer product acting on a ket $(|\beta\rangle\langle\alpha|)\cdot|\gamma\rangle$

because of the associative axiom, we can regard this equally well as,

$$|\beta\rangle\cdot(\langle\alpha|\gamma\rangle).$$

where $\langle\alpha|\gamma\rangle$ is just a number. So the outer product acting on a ket is just another ket. In other words $|\beta\rangle\langle\alpha|$ can be regarded as an operator.

If $\quad x = |\beta\rangle\langle\alpha|$

then $x^\dagger = |\alpha\rangle\langle\beta|$.

Theorem

The eigenvalue of a hermitian operator are real; the eigenkets of an operator corresponding to different eigenvalues are orthogonal.

Proof

consider two eigenkets $|a'\rangle$ and $|a''\rangle$.

$$A|a'\rangle = a'|a'\rangle \longrightarrow (1)$$

$$\langle a''|A = a''^*\langle a''| \longrightarrow (2)$$

(1) x $\langle a''|$ on both sides,

$$\langle a''|A|a'\rangle = a'\langle a''|a'\rangle \longrightarrow (3)$$

(2) $\times |a'\rangle$

$$\langle a''|A|a'\rangle = a''^* \langle a''|a'\rangle \longrightarrow (4)$$

(3) - (4)

$$0 = \langle a''|a'\rangle (a' - a''^*).$$

If $a' - a''^* = 0 \Rightarrow a' = a''^*$

which means eigenvalues are real.

or if $\langle a''|a'\rangle = 0$ the inner product is zero

i.e, orthogonal

(b) Given an observable A, then we define uncertainity relation as an operator,

$\Delta A = A - \langle A\rangle$, where the expectation value is to be taken for certain physical state under consideration. The $\langle (\Delta A)^2\rangle$ expectation of $(\Delta A)^2$ is known as dispersion of A. Sometimes the term 'variance' or 'mean square deviation' are used.

$$(\Delta A)^2 = A^2 - 2A\langle A\rangle + \langle A\rangle^2$$

and $\langle (\Delta A)^2\rangle = \langle A^2\rangle - 2\langle A\rangle^2 + \langle A\rangle^2$

$$\langle (\Delta A)^2\rangle = \langle A^2\rangle - \langle A\rangle^2$$

eg:- Spin half system.

let a state $|\psi\rangle = |x:+\rangle$

$\langle (\Delta S_x)^2 \rangle = \langle S_x^2 \rangle - \langle S_x \rangle^2$

$\langle S_x \rangle = \langle \psi | S_x | \psi \rangle = \langle + | S_x | + \rangle$

$S_x |+\rangle = \frac{\hbar}{2} \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \frac{\hbar}{2} \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \frac{\hbar}{2} |-\rangle$

$\langle + | S_x | + \rangle = \frac{\hbar}{2} \langle + | - \rangle = 0$

$S_x^2 = \left[\frac{\hbar}{2} \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \right]^2 = \frac{\hbar^2}{4} \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}$

$= \frac{\hbar^2}{4} \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$

$= \left(\frac{\hbar}{2}\right)^2 I.$

$\langle S_x^2 \rangle = \left(\frac{\hbar}{2}\right)^2 I$

$\langle (\Delta S_x)^2 \rangle = \left(\frac{\hbar}{2}\right)^2$

i.e, $\Delta S_x = \frac{\hbar}{2}$

Uncertainity Principle.

For two hermitian operator A and B, and a normalised state ψ, the uncertainity relation is given by

$(\Delta A)^2 . (\Delta B)^2 \geq \left| \langle \psi | \frac{1}{2i} [A, B] | \psi \rangle \right|^2$

$\Delta A . \Delta B \geq \langle \psi | \frac{1}{2i} [A, B] | \psi \rangle .$

eg:- position-momentum uncertainity,

$\Delta x . \Delta p \geq \hbar/2 .$

Energy time uncertainity relationes,

$$\Delta H \cdot \Delta t \geq \frac{\hbar}{2}$$

Proof

$A = \hat{H}$, $B = \hat{Q}(\hat{x}, \hat{p})$.

$$(\Delta H)^2 (\Delta Q)^2 \geq \left| \langle \psi | \frac{1}{2i} [H, Q] | \psi \rangle \right|^2 \longrightarrow (1)$$

$$\langle Q \rangle = \langle \psi | Q | \psi \rangle = \langle \psi, Q\psi \rangle$$

$$\frac{d\langle Q \rangle}{dt} = \left\langle \frac{d\psi}{dt}, Q\psi \right\rangle + \left\langle \psi, Q \frac{d\psi}{dt} \right\rangle$$

we have, $i\hbar \frac{d\psi}{dt} = H\psi$

$$\Rightarrow \frac{d\psi}{dt} = \frac{1}{i\hbar} H\psi$$

$$\frac{d}{dt}\langle Q \rangle = \left\langle \frac{1}{i\hbar} H\psi, Q\psi \right\rangle + \left\langle \psi, Q \frac{1}{i\hbar} H\psi \right\rangle$$

$$= \frac{-1}{i\hbar} \langle \psi, HQ\psi \rangle + \frac{1}{i\hbar} \langle \psi, QH\psi \rangle$$

$$= \frac{1}{-i\hbar} \left[\langle \psi, HQ\psi \rangle - \langle \psi, QH\psi \rangle \right]$$

$$= \frac{i}{\hbar} \langle \psi | [H, Q] | \psi \rangle$$

$$\frac{\hbar}{i} \frac{d\langle Q \rangle}{dt} = \langle \psi | [H, Q] | \psi \rangle \longrightarrow (2)$$

Let, $\Delta t = \dfrac{\Delta Q}{\frac{d\langle Q \rangle}{dt}}$

$$(\Delta H)^2 (\Delta Q)^2 \geq \left| \frac{1}{2i} \frac{\hbar}{i} \frac{d\langle Q \rangle}{dt} \right|^2$$

$$\geq \frac{\hbar^2}{4} \left[\frac{\Delta Q}{\Delta t} \right]^2$$

$$(\Delta H)^2 (\Delta t)^2 \geq \left(\frac{\hbar}{2}\right)^2$$

$\Rightarrow \Delta H \cdot \Delta t \geq \hbar/2$, the energy time uncertainity relation.

Uncertainity relation and its proofs

Given 2 hermitian operator A and B and a normalised steete ψ, then the following inequ-ality holds,

$$(\Delta A)^2 (\Delta B)^2 \geq \left| \langle \psi | \frac{1}{2i} [A, B] | \psi \rangle \right|^2$$

$$(\Delta A)(\Delta B) \geq \langle \psi | \frac{1}{2i} [A, B] | \psi \rangle$$

In order to prove, consider two variable α and β, we define $|\alpha\rangle = \Delta A |\psi\rangle$ where ψ is normalised.

$$|\alpha\rangle = \Delta A |\psi\rangle = (A - \langle A \rangle) |\psi\rangle \longrightarrow (1)$$

$$|\beta\rangle = \Delta B |\psi\rangle = (B - \langle B \rangle) |\psi\rangle \longrightarrow (2)$$

Then $(\Delta A)^2 = \langle \alpha | \alpha \rangle$

$(\Delta B)^2 = \langle \beta | \beta \rangle$

The schwartz inequality is,

$$|\alpha| \, |\beta| \geq |\langle \alpha | \beta \rangle|$$

Squaring,

$$|\langle \alpha | \alpha \rangle| \, |\langle \beta | \beta \rangle| \geq |\langle \alpha | \beta \rangle|^2 \longrightarrow (3)$$

Then, $\langle \alpha | \beta \rangle = \langle \psi | (\Delta A)(\Delta B) | \psi \rangle$

$$= \langle \psi | (A - \langle A \rangle)(B - \langle B \rangle) | \psi \rangle$$

$$= \langle \psi | AB | \psi \rangle + \langle A \rangle \langle B \rangle - \langle A \rangle \langle B \rangle + \langle A \rangle \langle B \rangle$$

$$= \langle \psi | AB | \psi \rangle - \langle A \rangle \langle B \rangle$$

Illy,

$$\langle \beta | \alpha \rangle = \langle \psi | BA | \psi \rangle - \langle A \rangle \langle B \rangle$$

The complete form of eqn (3),

$$(\Delta A)^2 (\Delta B)^2 \geq Re|\langle\alpha|\beta\rangle|^2 + Im|\langle\alpha|\beta\rangle|^2$$

$$Im(z) = \frac{z - z^*}{2i}$$

$$Im|\langle\alpha|\beta\rangle|^2 = \frac{1}{2i}\left[\langle\alpha|\beta\rangle - \langle\beta|\alpha\rangle\right]$$

$$= \frac{1}{2i}\left[\langle\psi|[A,B]|\psi\rangle\right]$$

If we are avoiding the positive real term,

eqn (3) $\Rightarrow$

$$(\Delta A)^2(\Delta B)^2 \geq \left|\langle\psi|\frac{1}{2i}[A,B]|\psi\rangle\right|^2$$

Q(2) S.T the eigen value of a hermitian operator are real

ans:- the eigen value of a hermitian operator are real; the eigen ket of an operator corresponding to different eigen values are orthogonal.

Proof

consider two eigen kets $|a'\rangle$ and $|a''\rangle$.

$A|a'\rangle = a'|a'\rangle \rightarrow (1)$ $\langle a''|A = a''^*\langle a''| \rightarrow (2)$

(1) $\times \langle a''|$ and (2) $|a'\rangle$.

$\Rightarrow \langle a''|A|a'\rangle = a'\langle a''|a'\rangle \rightarrow (3)$ and $\langle a''|Aa'\rangle = a''^*\langle a''|a'\rangle \rightarrow (4)$

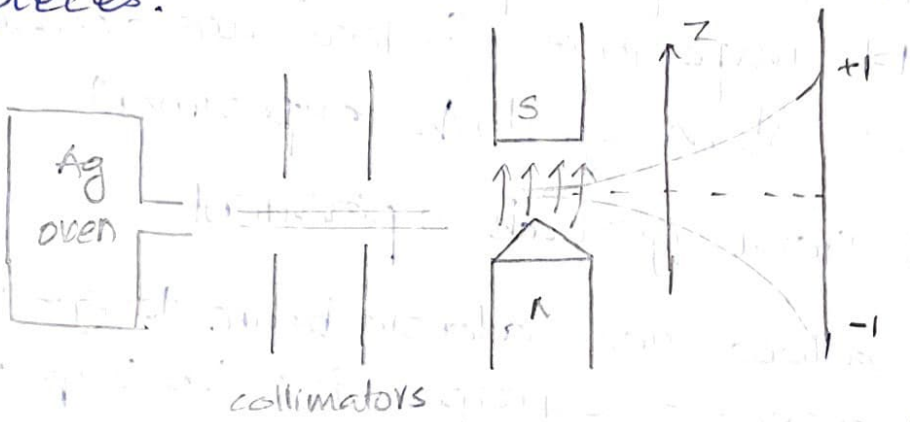
(3) $-$ (4) $\Rightarrow 0 = (a' - a''^*)\langle a''|a'\rangle$

If $a' - a''^* = 0$, the eigenvalues are real.

If $\langle a''|a'\rangle = 0$, the eigen ~~values~~ kets of the operator are orthogonal.

Q3) Describe the stern-gerlach expt and the one conclusion, which lead to the basics of Q.M.

ans:- The existence of spin was confirmed experimentally by stern and gerlac by silver atoms. First Ag atoms are heated in an oven which has a small hole through which some Ag atoms may escape. The beams goes through a collimator and is subjected to an inhomogeneous magnetic field produced by a pair of pole pieces.



The Ag atom is made of a nucleus and 47 $\bar{e}$s. Ag atom experiences a force, $F = -\nabla u$. and here, $u = -\mu \cdot B$. So that F becomes,

$$F = -\nabla(-\mu \cdot B) = \mu \cdot (\nabla B) = \mu \cdot \frac{\partial B}{\partial z}$$

If μ is +ve, Force is -ve. and Ag atoms are pushed downwards while if μ is -ve, F become +ve, where Ag atoms pulls upward.

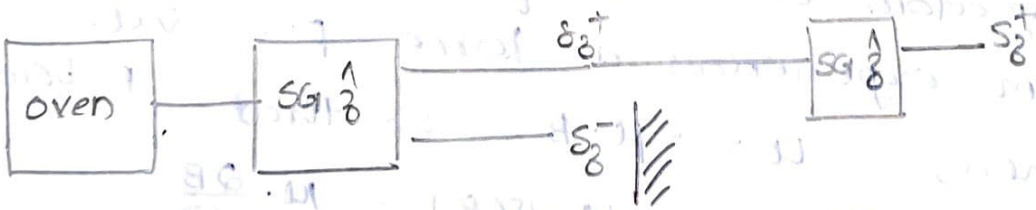
For Ag atoms, 46 out 47 $\bar{e}$s can be visualised as forming a spherically symmetric $\bar{e}$ cloud

with no net angular momentum. If we ignore the nuclear spin, the atoms as a whole does have angular momentum which is solely due to the spin of 47^{th} $\bar{e}$. As a result the heavy atom as a whole possesses a magnetic moment equal to the spin magnetic moment of 47^{th} $\bar{e}$.

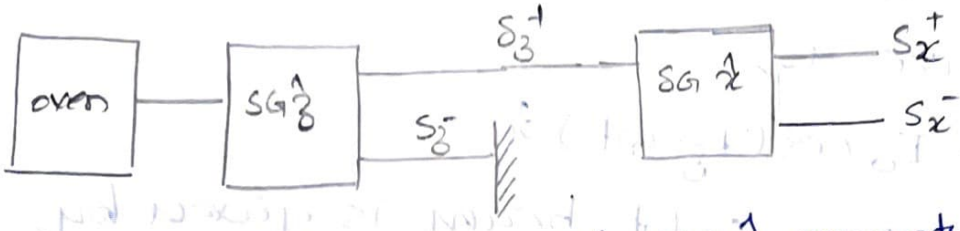
The experimental data corresponding to intrinsic spin angular momentum which can take two discrete value of S_z namely $\frac{1}{2}\hbar$ and $-\frac{1}{2}\hbar$. The quantization of $\bar{e}$ spin angular momentum is the 1st important feature we deduce from the Stern-Gerlach experiment.

Sequential stern-gerlach experiment.

Here we allow the atomic beam to goes through 2 or more SG apparatus in sequence.



In the above arrangement the S_z^- component coming out of the 1st SG apparatus is blocked and S_z^+ is allowed to go through 2nd SG apparatus. This time there is only one beam component coming out of the 2nd apparatus i.e, S_z^+.



here one S_z^+ beam 2nd SG $\hat{x}$ apparatus is now split into S_x^+ and S_x^- with equal intensities.

This time one S_x^- component of 2nd SG $\hat{x}$ apparatus is blocked and S_x^+ is allowed to pass through 3rd SG $\hat{z}$ apparatus. This example is often used to illustrate that in Q.M both S_z and S_x components we cannot determine simultaneously. i.e one selection of S_x beam by 2nd apparatus completely destroys any previous information about S_z. Peculiarities of Q.M are imposed upon us by the experiment itself and limitations are infact inherent in microscopic phenomenon.

Explanation.

Analogy with polarisation of light, consider a linearly polarised, monochromatic light wave propagating in z-direction and which

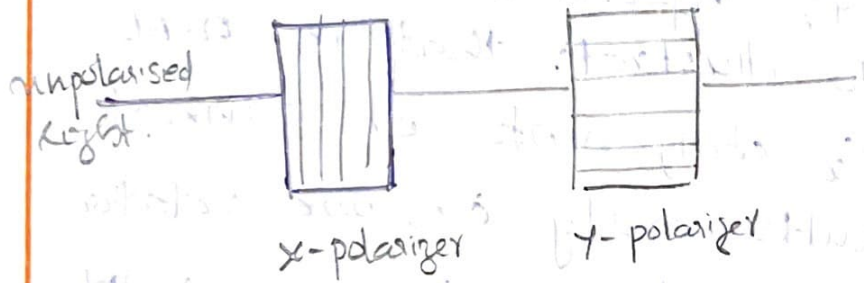
is polarised in x-direction. The electricfield of that wave is,

$$E = E_0 \cos(kz - \omega t)\,\hat{x}$$

A y-polarised light beam is given by

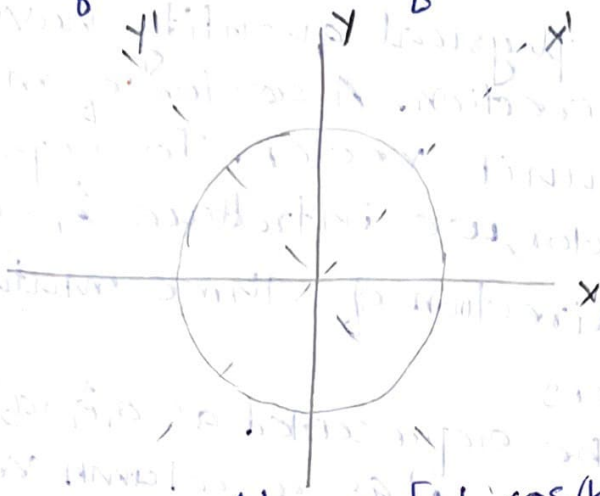
$$E = E_0 \cos(kz - \omega t)\,\hat{y}$$

These polarised beam can be obtained by letting an unpolarised light beam go through a poloroid filter. It is well known that when we let the light beam go through an x-filter and then by y-filter no light beams comes out.



If we insert, yet another poloroid between x-filter and y-filter that makes an angle 45^0 with the x-direction. This time there is a light beam coming out of the y-filter. despite of the fact that right after the beam bend through the x-filter, it didn't have any polarization component in the y-direction.

In the framework of classical electrodynamics,



$$E_0 \cos(kz-\omega t)\,\hat{x}' = E_0\left[\frac{1}{\sqrt{2}}\cos(kz-\omega t)\,\hat{x} + \frac{1}{\sqrt{2}}\cos(kz-\omega t)\,\hat{y}\right]$$

In the triple filter arrangement the 1st poloroid is an x-poloroid which can be regarded as a linear combination of x' and y'. The 2nd poloroid selects x' polarised beam which is a linear combination of x and y polarised beam and finally the third poloroid selects the y-polarised component.

Applying this to the sequential stern-gerlac experiment, the triple filter experiment suggests the spin states of Ag atom by some kind of vector, in a new kind of vector space.

So we may conjecture,

$$|S_x:+\rangle \stackrel{?}{=} \frac{1}{\sqrt{2}}|S_z:+\rangle + \frac{1}{\sqrt{2}}|S_z:-\rangle$$

$$|S_x:-\rangle \stackrel{?}{=} -\frac{1}{\sqrt{2}}|S_z:+\rangle + \frac{1}{\sqrt{2}}|S_z:-\rangle$$

Thus the unblocked component coming out of the 2nd SG apparatus (S_x^+) is to be regarded as a superposition of S_z^+ and S_z^-, it is for this reason that two components emerge from the third apparatus.