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M.Com. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Commerce

Paper X—PROJECT MANAGEMENT

(2016–2018 Admissions – Final Mercy Chance)

Time : Three Hours | Maximum Marks : 75

Section A

Answer **all** *questions.*

Each question carries 2 marks.

Answer not to exceed **half a page** *each.*

1. What do you understand by project identification ?
2. How does an entrepreneur identify project opportunities ?
3. What are the importance of market survey in project management ?
4. What is environmental feasibility ?
5. What is meant by social feasibility of project ?
6. What is a letter of credit ?
7. Distinguish between a Bill of Lading and a Shipping Bill.
8. Explain the Internal Rate of Return method.
9. What is Benefit-Cost Ratio ?
10. What is the importance of a project report in project management ?

(10 × 2 = 20)

Section B

Answer any **five** *questions.*

Each question carries 5 marks.

Answer not to exceed **one page** *each.*

11. What is project screening ? Explain the objectives and importance of project screening.
12. Briefly discuss the role of demand forecasting in determining the size of a project.

13. What is economic feasibility ? Explain its importance in project appraisal.

14. Briefly discuss the methods of estimating working capital requirements of a project.

15. What are the major problems faced by SSI units in Kerala ?

16. Explain the role of EXIM Bank in export finance.

17. How does decision tree analysis help in managing project risk ?

18. Explain the major contents of a project report.

(5 × 5 = 25)

Section C

Answer any **one** *question.*

This question carries 10 marks.

Answer not to exceed **three pages**.

19. "Technical feasibility is an essential component of project appraisal." Discuss the statement.

20. Explain the export procedure and documentation involved in international trade.

(1 × 10 = 10)

Section D

Answer any **one** *question.*

This question carries 20 marks.

Answer not to exceed **five pages**.

21. Explain the contribution of entrepreneurship to identifying and developing new project opportunities.

22. Briefly explain the various techniques of project appraisal and discuss their advantages and limitations.

(1 × 20 = 20)

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M.Com. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Commerce

Paper VII—HUMAN RESOURCE MANAGEMENT

(2016–2018 Admissions – Final Mercy Chance)

Time : Three Hours | Maximum Marks : 75

Section A

Answer **all** *questions.*

Each question carries 2 marks.

Answer not to exceed **half a page** *each.*

1. State the nature of Human Resource Management.
2. What is meant by auditing HR activities ?
3. Define Job Analysis and Job Specifications.
4. State the objectives of employee selection.
5. Define performance appraisal and state its significance.
6. Write a brief note on off-the-job training.
7. What is meant by group conflict ?
8. Define quality circle and explain its objectives
9. State the objectives of QWL.
10. Mention the major causes of employee stress.

(10 × 2 = 20)

Section B

Answer any **five** *questions.*

Each question carries 5 marks.

Answer not to exceed **one page** *each.*

11. Define HR planning and explain the various stages involved in the HR planning process.
12. Explain the need and techniques of job enrichment.

13. Explain the various internal sources of employee recruitment and selection.

14. Explain the relationship between employee motivation and morale.

15. Write a short essay on the objectives and functions of KILA as a training institution.

16. Discuss the causes and consequences of intra-group conflicts.

17. State the advantages and disadvantages workers' participation.

18. Briefly discuss the changing role of HR managers in the digital era.

(5 × 5 = 25)

Section C

Answer any **one** *question.*

This question carries 10 marks.

Answer not to exceed **three pages**.

19. Define HRM and explain its scope and functions in detail.

20. Explain the process of employee training and discuss the various methods of employee training.

(1 × 10 = 10)

Section D

Answer any **one** *question.*

This question carries 20 marks.

Answer not to exceed **five pages**.

21. Discuss the role of workers' participation in improving industrial relations and employee morale.

22. What is meant by measurement of group behavior ? Discuss the major tools and techniques used to assess group effectiveness.

(1 × 20 = 20)

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M.Com. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Commerce

Paper VI—FINANCIAL MANAGEMENT STRATEGIES

(2016—2018 Admissions—Final Mercy Chance)

Time : Three Hours | Maximum Marks : 75

(NPC is Permitted)

Section A

Answer **all** *questions.*
Each question carries 2 *marks.*
Answer not to exceed **half a page** *each.*

1. What is meant by the circular flow of working capital ?
2. What are the consequences of inadequate working capital ?
3. What is meant by optimum cash balance ?
4. Explain the role of near-cash assets in cash management.
5. What is inventory risk ?
6. What is safety stock ? Why is it maintained ?
7. Define average age of receivables. Why is it important in working capital management ?
8. What is dividend retention ratio ?
9. What is meant by marginal cost of capital ?
10. Explain the NOI approach to cost of capital.

(10 × 2 = 20)

Turn over

Section B

Answer any **five** *questions.*
Each question carries 5 *marks.*
Answer not to exceed **one page** *each.*

11. Briefly discuss the different types of working capital with suitable examples.

12. Explain the various motives of holding cash in business.

13. What are the different types of marketable securities suitable for temporary investment of surplus cash ?

14. What is the ABC analysis system of inventory control ?

15. Explain the various sources of credit information available to firms.

16. Explain the Gordon growth model of dividend policy.

17. Explain the concept of Weighted Average Cost of Capital.

18. A company earns Rs. 20 per share. Its rate of returns on investment is 18 % and cost of equity is 15 %. Calculate the market price per share under Walter's model when the dividend payout ratio is (a) 40% ; and (b) 75%.

(5 × 5 = 25)

Section C

Answer any **one** *question.*
This question carries 10 *marks.*
Answer not to exceed **three pages.**

19. What factors should a firm consider before deciding the terms of credit to customers. Explain.

20. A company manufactures and sell 60,000 units annually at selling price of Rs. 200 per unit. The cost per unit is :

Items		Rs.
Materials	...	80
Labour	...	40
Factory overhead	...	20
Administrate overhead	...	15
Selling overhead	...	10

The following information is available :

i) Raw materials storage 2 months

ii) Work-in-progress 1 month

iii) Finished goods storage 1 month

iv) Debtors 2 months

v) Creditors 1 month

vi) Wages and factory overheads outstanding ½ month each

vii) Administrative overheads outstanding 1 month

viii) Selling overhead outstanding 2 months

ix) Desired cash balance Rs. 75,000

Estimate the amount of working capital required.

(1 × 10 = 10)

Section D

Answer any **one** *question.*
This question carries 20 *marks.*
Answer not to exceed **five pages.**

21. Discuss the various strategies for effective working capital management in modern business enterprises.

22. The capital structure of a company is as follows :

Source	Book Value (Rs. in lakh)	Market Value (Rs. in lakh)
Equity Shares	80	120
Preference Shares	20	22
Debentures	40	38
Bank Loan	20	20

Additional information :

Cost of equity-18 %

Turn over

Preference dividend rate-12 %

Cost of debentures before tax-10 %

Cost of bank loan before tax-9 %

Corporate tax rate -30%

Calculate :

(i) After tax cost of debt and bank loan

(ii) WACC using book - value weights.

(iii) WACC using market-value weights.

(1 × 20 = 20)

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M.Com. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Commerce

Paper VIII—MANAGEMENT ACCOUNTING

(2016—2018 Admissions—Final Mercy Chance)

Time : Three Hours | Maximum Marks : 75

NPC Permitted

Section A

Answer **all** *questions.*
Each question carries 2 *marks.*
Answer not to exceed **half a page** *each.*

1. State the objectives of management Accounting.
2. What is a financial statement analysis ?
3. What are the limitations of financial accounting ?
4. How is a common-size income statement prepared ?
5. Explain the meaning of vertical and horizontal analysis ?
6. Explain profitability ratios and their significance.
7. Define operating ratio. What does a high operating ratio indicate ?
8. What is meant by 'fund' in fund flow analysis ?
9. What are the major classifications of cash flows ?
10. What is an internal report ?

(10 × 2 = 20)

Turn over

Section B

Answer any **five** *questions.*
Each question carries 5 *marks.*
Answer not to exceed **one page** *each.*

11. Explain the functions of a management accountant in an organization.

12. Explain the importance of debt-equity ratio and proprietary ratio.

13. Explain the importance of fund flow analysis in financial management.

14. What is working capital ? Explain its significance in fund flow analysis.

15. Calculate :

    (i) Return on Capital Employed (ROCE) ; and

    (ii) Return on Equity.

    Net profit after Tax–Rs. 2,40,000

    Preference dividend–20,000

    Equity Shareholder's Funds–8,00,000

    Long term Debt–4,00,000

    Interest on long term Debt–40,000.

16. From the following ratios, calculate the missing figures :

    - Current ratio = 2.5 : 1
    - Quick ratio = 1.5 : 1
    - Current liabilities = Rs. 2,00,000
    - Gross profit ratio = 25 %
    - Sales = Rs. 10,00,000

    Calculate :

    (i) Current and quick assets ;

    (ii) Inventory ;

    (iii) Cost of goods sold ; and

    (iv) Working capital.

17. Calculate funds from operations from the information given below as on 31st March, 2025 :

(a) Net profit for the year ended 31st March 2025 Rs. 6,50,000.

(b) Gain on the sale of building Rs. 35,000.

(c) Goodwill appears in the books at Rs. 1,80,000 out of that 10 % has been written off during the year.

(d) Old machinery worth Rs. 8,000 has been sold for Rs. 6,500 during the year.

(e) Rs. 1,25,000 have been transferred to Reserve Fund.

(f) Depreciation has been provided during the year on machinery and furniture at 20 % whose total is Rs. 6,50,000

(g) Preliminary expenses written off during the year Rs. 5,000.

(h) Dividend received during the year Rs. 8,600.

18. The sales and gross profit of a company are :

Year	Sales	Gross Profit
	Rs.	Rs.
2017	2,50,000	30,000
2018	3,00,000	34,000
2019	4,00,000	38,000
2020	3,40,000	29,000
2021	2,90,000	26,000
2022	3,60,000	40,000
2023	4,00,000	48,000
2024	4,60,000	49,000
2025	5,00,000	60,000

Calculate the trend percentage for sales and gross profit, taking 2017 as the base year.

(5 × 5 = 25)

Turn over

Section C

Answer any **one** *question.*
This question carries 10 *marks.*
Answer not to exceed **three pages.**

19. "Accounting ratios are important tools for financial decision making." Discuss the statement with suitable examples.

20. Balance Sheets of B and W Ltd. as on 1st January and 31st December 2025 were as follows :

Liabilities	1.1.25 Rs.	31.12.25 Rs.	Assets	1.1.25 Rs.	31.12.25 Rs.
Creditors	40,000	44,000	Cash	10,000	7,000
W's loan	25,000	—	Debtors	30,000	50,000
Loan from bank	40,000	50,000	Stock	35,000	25,000
Capital	1,25,000	1,53,000	Machinery	80,000	55,000
			Land	40,000	50,000
			Buildings	35,000	60,000
	2,30,000	2,47,000		2,30,000	2,47,000

During the year machine costing Rs. 10,000 (accumulated depreciation Rs. 3,000) was sold for Rs. 5,000. The provision for depreciation against machinery as on 1st January 2025 was Rs. 25,000 and on 31st December 2025 Rs. 40,000. Net profit for the year 2025 amounted to Rs. 45,000. Prepare Cash Flow Statement.

(1 × 10 = 10)

Section D

Answer any **one** *question.*
This question carries 20 *marks.*
Answer not to exceed **five pages.**

21. "An efficient management reporting system is essential for efficient managerial control." Discuss the statement in detail.

22. Debtors Velocity 3 months

Creditors Velocity 2 months

Fixed Assets Turnover Ratio 8 times

Gross Profit Turnover Ratio 25 %

Gross profit for the comes to Rs. 80,000

There is no long term loan or overdraft

Reserves and Surplus amounted to Rs. 28,000

Liquid Assets are Rs. 97,333

Closing stock is Rs. 2,000 more than the Closing Stock

Bills Receivable and Bills Payable are Rs. 5,000 and Rs. 2,000 respectively.

Find out :

(a) Sales ;

(b) Sundry Debtors ;

(c) Closing Stock ;

(d) Sundry Creditors ;

(e) Fixed Assets ;

(f) Proprietor's Fund ;

(g) Make out the Balance Sheet with as many details as possible.

(1 × 20 = 20)

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M.Com. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Commerce

Paper IX—OPERATIONS RESEARCH

(2016–2018 Admissions–Final Mercy Chance)

Time : Three Hours | Maximum Marks : 75

(NPC permitted)

Section A

Answer **all** *questions.*
Each question carries 2 marks.
Answer not to exceed **half a page**.

1. What is meant by an Operations Research model ?
2. List any four characteristics of Operations Research.
3. Distinguish between a slack variable and a surplus variable.
4. State the principles of duality in linear programming. .
5. What is meant by a balanced transportation problem?
6. What is an optimal assignment ?
7. What is meant by a replacement decision in Operations Research ?
8. Explain the meaning of pure strategy and mixed strategy.
9. Explain the Maximin and Minimax principles.
10. What are the different types of float in CPM ?

(10 × 2 = 20)

Section B

Answer any **five** *questions.*

Each question carries 5 marks.
Answer not to exceed **one page** *each.*

11. Explain the importance of Operations Research in managerial decisionmaking.
12. Explain the basic components of an LPP with a suitable numerical examples.

13. What is a critical path ? Explain its significance.

14. Explain the principle of dominance in Game Theory.

15. Solve the following transportation problem.

		Warehouse			
	W_1	W_2	W_3	W_4	Capacity
F_1	19	30	50	10	7
F_2	70	30	40	60	9
F_3	40	8	70	20	18
Requirement	5	8	7	14	

16.

AIB	B_1	B_2
A_1	5	2
A_2	3	4

Determine the optimal mixed strategies and the value of the game.

17. A company produces product X and Y. The profits per unit is Rs.50 for X and Rs.40 for Y. Product X requires 3 units of raw material and 2 labour hours, whereas Y requires 2 units of raw material and 3 labour hours.

The company has 120 units of raw material and 150 labour hours available. Formulate and solve the LPP graphically.

18. Find the Critical path

Activity	Duration
A-B	3
A-C	5
B-D	4
C-D	2
D-E	6

(5 × 5 = 25)

Section C

Answer any **one** *question.*
The question carries 10 marks.

19. Five different machines can do any of the five required jobs with different profits resulting from each assignment as shown below :

		Machines				
		A	B	C	D	E
	1	30	37	40	28	40
	2	40	24	27	21	36
Job	3	40	32	33	30	35
	4	25	38	40	36	36
	5	29	62	41	34	39

Find out maximum profit possible through optimal assignment.

Turn over

20. Find the optimal replacement policy for the following problem. The cost of machine is Rs. 5,000. The running cost and salvage values are given below :

Year	Running Rs.	Salvage value Rs.
1	1,500	3,500
2	1,600	2,500
3	1,800	1,700
4	2,100	1,200
5	2,500	800
6	2,900	500
7	3,400	500
8	4,000	500

(1 × 10 = 10)

Section D

Answer any **one** *question.*

This question carries 20 marks.

21. Solve the following problem:

Maximize $Z = 6x_1 + 4x_2$

Subject to $-2x_1 + x_2 \leq 2$

$x_1 - x_2 \leq 2$

$3x_1 + 2x_2 \leq 9$

$x_1, x_2 \geq 0$

22. The following table gives the activities in a construction project and other relevant information.

Activity :	1—2	1—3	2—3	2—4	3—4	4—5
Duration :	20	25	10	12	6	10

(i) Draw the network for the project

(ii) Find free, total and independent floats for each activity

(iii) Which are the critical activities.

(1 × 20 = 20)

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M.Sc. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Science

Branch I (A) : Mathematics

Paper IX—COMPLEX ANALYSIS—I

(2016—2018 Admissions—Final Mercy Chance)

Time : Three Hours Maximum Marks : 75

Answer **either** *Part A* **or** *Part B of each question.*
Each question carries 15 *marks.*

I. A (i) Show that an analytic function in a region Ω must reduce to a constant if either the real part, the imaginary part, the modulus or the argument is constant.

(ii) Define a linear transformation and show that the reflection $z \to \bar{z}$ is not a linear transformation.

(iii) Define the cross ratio (z_1, z_2, z_3, z_4) and prove that the cross ratio (z_1, z_2, z_3, z_4) is real if and only if the four points lie on a circle or on a straight line.

B (i) Find the linear transformation which carries the circle $|z| = 2$ into $|z+1| = i$ the point -2 into the origin and the origin to i.

(ii) Find the fixed points of the linear transformation $w = \dfrac{2z}{3z-1}$.

(iii) Describe the Riemann surface associated with the function $w = \dfrac{1}{2}\left(z + \dfrac{1}{z}\right)$.

II. A (i) Compute $\int_{\gamma} x\, dz$ where γ is the directed line segment from 0 to $1 + i$.

Turn over

(ii) State and prove Cauchy's theorem for a rectangle.

(iii) Compute $\int_{\gamma} \frac{e^z}{2}\, dz,$ where γ is the circle $|z| = 1.$

B (i) Suppose that $\phi(\mathcal{J})$ is continuous on the are γ. Prove that the function $\mathrm{F}_n(z) = \int_{\gamma} \frac{\phi(\mathcal{J})\, d\mathcal{J}}{(\mathcal{J} - z)^n}$

is analytic in each of the regions determined by γ, and its derivative is $\mathrm{F}_n(z) = n\, \mathrm{F}_{n+1}(2).$

(ii) Compute $\int_{|z|=1} e^z\, z^{-n}\, dz.$

(iii) State and prove fundamental theorem of algebra.

III. A (i) State and prove Taylor's theorem.

(ii) Show that a function which is analytic in the whole plane and has non-essential singularity at infinity reduces to a polynomial.

(iii) Define the terms pole and essential singularity.

B (i) State and prove the maximum principle.

(ii) State and prove the Schwarz lemma.

(iii) State Movera's theorem.

IV. A (i) Define a simply connected region and show that a region is simple connected if and only if $n(\gamma, a) = 0$ for all cycles γ in Ω and all points 'a' which do not belong to Ω.

(ii) Prove that if $f(z)$ is analytic and $\neq 0$ in a simply connected region Ω, then if is possible to define single valued analytic branch of $\log f(z)$ and $\sqrt[n]{f(z)}$ in Ω.

(iii) State and prove Rouche's theorem.

B (i) State and prove the residue theorem.

(ii) Find the poles and residues of $\frac{1}{\left(z^2-1\right)^2}$.

(iii) Evaluate $\int_0^\infty \frac{x^2\,dx}{x^4+5x^2+6}$.

V. A (i) Define a harmonic function and prove that the arithmetic mean of a harmonic function over concentric circles $|z|=r$ is a linear function of $\log r$.

(ii) State the maximum principle.

(iii) State and prove Hurwitz theorem.

B (i) Develop $\log(\sin z/z)$ in powers of z upto the term z^6.

(ii) Describe the Laurent series development.

(iii) Find the Laurent series that represents the function $f(z)=z^2\sin\left(\frac{1}{z^2}\right)$ in the domain $0<|z|<\infty$.

(5 × 15 = 75)

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M.Sc. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Science

Branch I (A) : Mathematics

Paper VIII—TOPOLOGY – II

(2016 – 2018 Admissions–Final Mercy Chance)

Time : Three Hours Maximum Marks : 75

Answer **either** *Part A* **or** *Part B of each question.*

Each question carries 15 marks.

I. A i) Define the T_0, T_1 and T_2 axioms.

ii) Define a completely regular space and show that every completely regular space is regular.

iii) Prove that a continuous bijection from a compact space onto a Hausdorff space is a homeomorphism.

B i) State and prove Urysohn's lemma.

ii) Prove that a compact subset in a Hausdorff space is closed.

II. A i) Define product topology and define the standard base and sub-base fo the product topology.

ii) Prove that a product of space is connected if and only if each co-ordinate space is connected.

B i) Let $X = \underset{i \in I}{\pi} X_i$, each X_i being a topological space. Suppose $\{x_n\}$ is a sequence in X and $x \in X$. Prove that $\{x_n\}$ converges to $x \in X$ if and only if for each $i \in I$, the sequence $(\pi_i(x_n))$ converges to $\pi_i(x)$ in X_i.

ii) Prove that a product of topological spaces is path-connected if and only if each co-ordinate space is path connected.

III. A i) Prove that a topological space is a Tychonoff space if and only if it is embeddable into a cube.

ii) Prove that a topological space is completely regular if and only if the family of continuous real-valued functions on it distinguishes points from closed sets.

B i) Prove that a topological space is embeddable in the Hilbert cube if and only if it is second countable and T_3.

ii) State and prove Urysohn's metrisation theorem.

IV. A i) Define a net and define its convergence in a topological space.

ii) Prove that a topological space is Hausdorff if and only if limits of all nets in it are unique.

iii) Define a filter and define its convergence.

B i) Prove that every filter is contained in an ultra filter.

ii) Prove that a topological space is compact if and only if every ultrafilter in it is convergent.

V. A i) Define countably compact and sequentially compact space.

ii) Prove that a first countable, countably compact space is sequentially compact.

iii) Prove that in a second countable space, compactness, countable compactness and sequential compactness are all equivalent to each other.

B i) Prove that a topological space X is compact if and only if there exists a closed sub-base $\mathcal{C}$ for X such that every sub family of $\mathcal{C}$ having the finite intersection property has a non-empty intersection.

ii) Define a locally compact space and give an example.

iii) Explain the terms n-point compactification and Stone–Cech compactification of a space X.

(5 × 15 = 75)

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M.Sc. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Science

Branch I (A)—Mathematics

Paper VII—REAL ANALYSIS

(2016—2018 Admissions—Final Mercy Chance)

Time : Three Hours Maximum Marks : 75

Answer **either** *Part A or Part B of each question.*

Each question carries 15 *marks.*

I. (A) (i) If $\{f_n\}$ and $\{g_n\}$ converge uniformly on a set E, prove that $\{f_n + g_n\}$ converges uniformly on E.

(ii) State and prove Cauchy Criterion for uniform convergence.

(iii) Let α be monotonically increasing on $[a, b]$. Suppose $f_n \in \mathrm{R}(\alpha)$ *on* $[a, b]$ for $n = 1, 2, 3 \ldots$ and suppose $f_n \to f$ uniformly on $[a, b]$. Prove that $f \in \mathrm{R}(\alpha)$ on $[a, b]$ and $\int_a^b f d\alpha = \lim_{n \to \infty} \int_a^b f_n d\alpha$.

(B) (i) Suppose $f_n \to f$ uniformly on a set E in a metric space. Let x be a limit point of E, and suppose that $\lim_{t \to x} f_n(t) = \mathrm{A}_n$ for n = 1, 2, 3 ....

Prove that $\{\mathrm{A}_n\}$ converges and $\lim_{t \to x} f(t) = \lim_{n \to \infty} \mathrm{A}_n$.

(ii) Suppose K is compact and :

(a) $\{f_n\}$ is a sequence of continuous functions on K.

Turn over

(b) $\{f_n\}$ converges pointwise to a continous function f on K.

(c) $f_n(x) \geq f_{n+1}(x)$ for all $x \in K$, $n = 1, 2, 3, ...$

Prove that $f_n \to f$ uniformly on K.

II. (A) (i) Suppose $\{f_n\}$ is a sequence of functions, differentiable on $[a, b]$ and such that $\{f_n(x_0)\}$ converges for some point x_0 on $[a, b]$. Prove that if $\{f_n'\}$ converges uniformly on $[a, b]$, then $\{f_n\}$ converges uniformly on $[a, b]$ to a function f and $f'(x) = \lim_{n \to \infty} f_n'(x)$ for $a \leq x \leq b$.

(ii) Prove that there exists a real continuous function on the real line which is nowhere differentiable.

(B) (i) If K is a compact, if $f_n \in \mathcal{C}(K)$ for $n = 1, 2 ....$ and if $\{f_n\}$ is point wise bounded and equicontinuous on K, then prove that :

(a) $\{f_n\}$ is uniformly bounded on K.

(b) $\{f_n\}$ contains a uniformly convergent subsequence.

(ii) For $n = 1, 2, ..., x$ real, put $f_n(x) = \frac{x}{1 + nx^2}$, show that $\{f_n\}$ converges uniformly to a function f and that the equation $f'(x) = \lim_{n \to \infty} f_n'(x)$ is correct if $x \neq 0$, but false if $x = 0$.

III. (A) (i) Calculate all first order partial derivatives and the directional derivative $f'(x, u)$ for the real valued function f defined on R^4 by $f(x) = \|x\|^4$.

(ii) Assume that f is differentiable at c with total derivative T_c. Show that the directional derivative $f'(c, u)$ exists for every u in R^n and $T_c(u) = f'(c, u)$.

(iii) Prove that if f is differentiable at a point c, then f is continuous at c.

(B) (i) Calculate the Jacobian matrix for the function $f : \mathrm{R}^2 \to \mathrm{R}^3$ defined by

$f(x, y) = (\sin x \cos y,\ \sin x \sin y,\ \cos x \cos y)$.

(ii) Let $f = u + iv$ be a complex valued function of a complex variable. Show that Cauchy-Riemann equations along with differentiability of u and v imply existence of $f'(c)$, where c be an interior point of a subset s of the complex plane and u and v, real valued functions defined on s.

IV. (A) (i) State and prove the mean value theorem.

(ii) Let S be an open connected subset of R^n and let $f : \mathrm{S} \to \mathrm{R}^n$ be differentiable at each point of S. If $f'(c) = 0$ for each $c \in \mathrm{S}$, Prove that f is constant on S.

(iii) Compute $\nabla f(x,y)$ at those points (x,y) in R^2 where it exists for the function $f(x, y) = x^2\, y^2 \log\left(x^2 + y^2\right)$ if $(x, y) \neq (0, 0)$ and $f(0, 0) = 0$.

(B) (i) For the function $f(x, y) = \log\left(x^2 + y^2\right), (x, y) \neq (0, 0)$ verify that the mixed partial derivatives $\mathrm{D}_{1,2} f$ and $\mathrm{D}_{2,1} f$ are equal.

(ii) State and prove that Taylor's formula.

V. (A) (i) If $f = u + iv$ is a complex valued function with a derivative at a point z in C, then show that $\mathrm{J}_f(z) = |f'(z)|^2$.

(ii) State the inverse function theorem.

(iii) Let A be an open subset of R^n and assume that $f : \mathrm{A} \to \mathrm{R}^n$ has continuous partial derivatives $\mathrm{D}f_i$ on A. Prove that if $\mathrm{J}_f(x) \neq 0$ for all $x \in \mathrm{A}$, then f is an open map.

(b) State and prove the implicit function theorem.

(5 × 15 = 75)

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M.Sc. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Science

Branch I (A)—Mathematics

Paper VI—ABSTRACT ALGEBRA

(2016—2018 Admissions—Final Mercy Chance)

Time : Three Hours Maximum Marks : 75

Answer **either** *Part A or Part B of each question.*

Each question carries 15 *marks.*

I. (A) (i) Define the direct product of n groups and show that $\prod_{i=1}^{n} \mathrm{G}i$ is a group.

(ii) Find the order of the element (2, 6) in the direct product $z_4 + z_{12}$.

(iii) Prove that if m is a square free integer, then every abelian group of order m is cyclic.

(B) (i) Let p be a prime and G be a finite group and p divide $|\mathrm{G}|$. Prove that G has an element of order p.

(ii) State first Sylow Theorem.

(iii) Prove that for a prime number p, every group G of order p^2 is abelian.

II. (A) (i) Prove that the set $\mathrm{R}[x]$ of all polynomials in an indeterminate x with co-efficients in a ring R is a ring under polynomial addition and multiplication. Also prove that in R is commutative, so is R [x].

(ii) Prove that the polynomial $x^2 - 2$ has no zeros in the rational numbers.

Turn over

(B) (i) Prove that a non-zero polynomial $f(x) \in F[x]$ of degree n can have at most n zeros in a field F.

(ii) Let $f(x) \in F[x]$ and let $f(x)$ be of degree 2 or 3. Prove that $f(x)$ is irreducible over F if and only if it has a zero in F.

(iii) State and prove Eisenstein Criterion.

III. (A) (i) Show that $1+i$ is algebraic over Q.

(ii) Show that the polynomial $x^2 - 1$ is irreducible in $z_3[x]$.

(iii) Prove that a field F is algebraically closed if and only if every non-constant polynomial in F [x] factors in F [x] into linear factors.

(B) (i) Prove that the field C of complex numbers is an algebraically closed field.

(ii) Find the degree and a basis for $Q(\sqrt{2}, \sqrt{3})$ over Q.

(iii) Prove that trisecting the angle is impossible.

IV. (A) (i) Prove that the set of all automorphisms of a field E is a group under function composition.

(ii) Find all conjugates in C of $\sqrt{2} - \sqrt{3}$ over Q.

(iii) Define the index of an extension field E over a field F and prove that if $F \leq E \leq K$, where K is a finite extension field of the field F, then prove that $\{K:F\} : \{K:E\}\{E:F\}$.

(B) (i) Find the degree over Q of the splitting field over Q of the polynomial $x^4 - 1$ in $Q[x]$.

(ii) Prove that if $E \leq \bar{F}$ is a splitting field over F, then every irreducible polynomial in F [x] having a zero in E splits in E.

(iii) Find the order of G $\left(Q(\sqrt[3]{2})/Q\right)$.

V. (A) (i) Let $f(x)$ be irreducible in $F[x]$. Prove that all zeros of $f(x)$ in $\bar{F}$ have the same multiplicity.

(ii) Prove that if $F \leq E \leq K$, then K is separable over F if and only if K is separable over E and E is separable over F.

(iii) Prove that every field of characteristic zero is perfect.

(B) (i) State the main theorem of Galois Theory.

(ii) Prove that a finite field GF (p^n) of p^n elements exists for every prime power p^n.

(iii) Prove that if F is any finite field, then for every positive integer n, there is an irreducible polynomial in $F[x]$ of degree n.

$(5 \times 15 = 75)$

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M.Sc. DEGREE (PRIVATE) EXAMINATION, JULY 2026

Second Semester

Faculty of Science

Branch I (A) : Mathematics

Paper X—FUNCTIONAL ANALYSIS – I

(2016 – 2018 Admissions–Final Mercy Chance)

Time : Three Hours Maximum Marks : 75

Answer **either** *Part A* **or** *Part B of each question.*
Each question carries 15 marks.

I. A i) Define a Banach space and illustrate it with an example.

ii) Show that a metric '*d*' induced by a norm on a normed space X is translation invariant.

iii) Let T be a linear operator, Prove that (a) the range R (T) is a vector space.

iv) If $\dim D(T) = n < \infty$, then $\dim R(T) \leq n$. Show that R^n is not compact.

B i) State and prove Riesz's lemma.

ii) Prove that if a normed space X has the property that the closed unit ball $\mu = \{x / \|x\| \leq 1\}$ is compact, then X is finite dimensional.

iii) Let X and Y be metric spaces and $T : X \to Y$ a continuous mapping. Prove that the image of a compact subset μ of X under T is compact.

II. A i) Let $T : D(T) \to Y$ be a linear operator $D(T) \subset X$ and X,Y are normed spaces.

Prove that (a) T is continuous if and only if T is bounded.

(b) If T is continuous at a single point, it is continuous.

ii) Let X be an n-dimensional vector space and $E=\{e_1,e_2..e_n\}$ a basis for X. Show that $F=\{f_1,f_2,..,f_n\}$ given by $f_n(e_j)=\delta_{jk}=\begin{cases}0 \text{ if } i\neq k\\1 \text{ if } i=k\end{cases}$ is a basis for the algebraic dual X^* of and that dim X^* = dim X = n.

iii) Find the dual basis of the basis $\{(1,0,0),(0,1,0),(0,0,1)\}$for R^3.

B i) Prove that the dual of l^p is l^q, where $1<p<\infty$ and $\frac{1}{p}+\frac{1}{q}=1$.

ii) Define a bounded linear functional and prove that a linear functional with domain D (f) in a normed space is continuous if and only if it is bounded.

III. A i) Define an inner product space and show that l^p with $p\neq 2$ is not an inner product space.

ii) Prove that in an inner product space if $x_n\to x$ and $y_{n\to y}$, then $\langle x_n,y_n\rangle\to\langle x,y\rangle$.

iii) Let Y be a closed subspace of a Hilbert space H. Prove that $H=Y\oplus Z$ where $Z=Y^{\perp}$.

B i) State and prove Bassel's inequality.

ii) Define an orthonormal set in an inner product space and prove that an orthonormal set is linearly independent.

iii) Give an orthonormal sequence in l^2.

IV. A i) Prove that an orthonormal set μ in a Hilbert space H is total in H if and only if for all $x\in H$, the parseval relation $\sum_k|<x,e_k>0\leq|^2\leq\|x\|$ holds.

(ii) Prove that two Hilbert spaces H and $\tilde{H}$, both real or both complex, are isomorphic if and only if they have the same Hilbert dimension.

B i) State and prove Riesz's theorem for functionals on Hilbert spaces.

ii) Define self adjoint, unitary and normal operators on Hilbert spaces.

iii) Let $T : H \to H$ be a bounded linear operator on a Hilbert space H. Prove that if T is self adjoint, then $\langle Tx, x \rangle$ is real for all $x \in H$.

V. A i) State and prove the generalized Hahn-Banach theorem.

ii) State Zorn's lemma and prove that every vector space $X \neq \{0\}$ has a Hamel basis.

B i) Define the adjoint T^X, where $T :\to Y$ be a bounded linear operator, where X and Y are normed spaces.

ii) Prove that the adjoint operator T^X is linear and bounded and $\|T^X\| = \|T\|$.

iii) Define a reflexive space and prove that if a normed space X is reflexive, if is complete.

iv) State Baire's category theorem.

(5 × 15 = 75)