Thoroughly Revised and Updated

GATE

• 2017 •

Computer Science & IT

25 Years GATE solved papers
with thorough explanations

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GATE - 2017 : Computer Science & IT Topicwise Previous GATE Solved Papers (1992-2016)

First Edition : 2007
Second Edition : 2008
Third Edition : 2009
Fourth Edition : 2010
Fifth Edition : 2011
Sixth Edition : 2012
Seventh Edition : 2013
Eighth Edition : 2014
Ninth Edition : 2015
Tenth Edition : 2016

Preface

B. Singh (Ex. IES)

Over the period of time the GATE examination has become more challenging due to increasing number of candidates. Though every candidate has ability to succeed but competitive environment, in-depth knowledge, quality guidance and good source of study is required to achieve high level goals.

The new edition of **GATE 2017 Solved Papers : Computer Science & IT** has been fully revised, updated and edited. The whole book has been divided into topicwise sections.

At the beginning of each subject, analysis of previous papers are given to improve the understanding of subject. This book also contains the conventional questions asked in GATE before 2003.

I have true desire to serve student community by way of providing good source of study and quality guidance. I hope this book will be proved an important tool to succeed in GATE examination. Any suggestions from the readers for the improvement of this book are most welcome.

B. Singh (Ex. IES)
Chairman and Managing Director
MADE EASY Group

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Unit . I

Discrete and Engineering Mathematics

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UNIT I

Discrete and Engineering Mathematics

Syllabus :

Mathematical Logic: Propositional and first order logic.

Set Theory & Algebra: Sets, relations, functions, partial orders and lattices. Groups.

Combinatorics: Counting, recurrence relations, generating functions.

Graph Theory: Connectivity, matching, coloring.

Probability: Random variables. Uniform, normal, exponential, poisson and binomial distributions. Mean, median, mode and standard deviation. Conditional probability and Bayes theorem.

Linear Algebra: Matrices, determinants, system of linear equations, eigenvalues and eigenvectors, LU decomposition.

Calculus: Limits, continuity and differentiability. Maxima and minima. Mean value theorem. Integration.

Analysis of Previous GATE Papers

Exam Year	1 Mark Ques.	2 Marks Ques.	3 Marks Ques.	5 Marks Ques.	Total Marks
1990	1	2		–	**5**
1991	–	1		–	**2**
1992	3	1		3	**20**
1993	3	–		1	**8**
1994	4	5		–	**14**
1995	4	5		1	**19**
1996	7	7		–	**21**
1997	4	7		–	**18**
1998	7	7		1	**26**
1999	4	5		2	**24**
2000	2	5		2	**22**
2001	4	5		–	**14**
2002	6	4		3	**29**
2003	5	15		–	**35**
2004	5	11		–	**27**
2005	5	10		–	**25**
2006	3	10		–	**23**

Exam Year	1 Mark Ques.	2 Marks Ques.	Total Marks
2007	4	9	**22**
2008	4	10	**24**
2009	4	6	**16**
2010	6	8	**24**
2011	–	5	**10**
2012	6	5	**16**
2013	6	3	**12**
2014 Set-1	6	9	**24**
2014 Set-2	5	8	**21**
2014 Set-3	7	8	**23**
2015 Set-1	5	8	**21**
2015 Set-2	5	8	**21**
2015 Set-3	7	6	**19**
2016 Set-1	5	4	**13**
2016 Set-2	6	3	**12**

1 Mathematical Logic

1.1 Indicate which of the following well-formed formula are valid:

(a) $((P \Rightarrow Q) \wedge (Q \Rightarrow R)) \Rightarrow (P \Rightarrow R)$

(b) $(P \Rightarrow Q) \Rightarrow (\neg P \Rightarrow \neg Q)$

(c) $(P \wedge (\neg P \vee \neg Q)) \Rightarrow Q$

(d) $((P \Rightarrow R) \vee (Q \Rightarrow R)) \Rightarrow ((P \vee Q)) \Rightarrow R)$.

[1990 : 2 Marks]

1.2 Which of the following predicate calculus statements is/are valid

(a) $(\forall x)\ P(x) \vee (\forall x)\ Q(x) \rightarrow (\forall x)\ \{P(x) \vee Q(x)\}$

(b) $(\exists x)\ P(x) \wedge (\exists x)\ Q(x) \rightarrow (\exists x)\ \{P(x) \wedge Q(x)\}$

(c) $(\exists x)\ \{P(x) \vee Q(x)\} \rightarrow (\forall x)\ P(x) \vee (\forall x)\ Q(x)$

(d) $(\exists x)\ \{P(x) \vee Q(x)\} \rightarrow \sim (\forall x)$

[1992 : 1 Mark]

1.3 Which of the following is/are tautology:

(a) $(a \vee b) \rightarrow (b \wedge c)$ (b) $(a \wedge b) \rightarrow (b \vee c)$

(c) $(a \vee b) \rightarrow (b \rightarrow c)$ (d) $(a \rightarrow b) \rightarrow (b \rightarrow c)$

[1992 : 1 Mark]

1.4 The proposition $p \wedge (\sim p \vee q)$ is

(a) a tautology (b) $\Leftrightarrow (p \wedge q)$

(c) $\Leftrightarrow (p \vee q)$ (d) a contradiction

[1993 : 1 Mark]

1.5 Let p and q be propositions. Using only the truth table decide whether $p \Leftrightarrow q$ does not imply $p \rightarrow \neg q$ is true or false.

[1994 : 2 Marks]

1.6 If the proposition $\neg p \Rightarrow q$ is true, then the truth value of the proposition $\neg p \vee (p \Rightarrow q)$, where $\neg$ is negation, '$\vee$' is inclusive or and '$\Rightarrow$' is implication, is

(a) true (b) multiple valued

(c) false (d) cannot be determined

[1995 : 2 Marks]

1.7 Which one of the following is false? Read $\wedge$ as AND, $\vee$ as OR, $\sim$ as NOT, $\rightarrow$ as one way implication and $\leftrightarrow$ as two way implication.

(a) $((x \rightarrow y) \wedge x) \rightarrow y$

(b) $((\sim x \rightarrow y) \wedge (\sim x \rightarrow \sim y)) \rightarrow x$

(c) $(x \rightarrow (x \vee y))$

(d) $((x \vee y) \leftrightarrow (\sim x \rightarrow \sim y))$

[1996 : 2 Marks]

1.8 Let a, b, c, d be propositions. Assume that the equivalence $a \leftrightarrow (b \vee \neg b)$ and $b \leftrightarrow c$ hold. Then the truth-value of the formula $(a \wedge b) \rightarrow (a \wedge c) \vee d$ is always

(a) True

(b) False

(c) Same as the truth-value of b

(d) Same as the truth-value of d

[2000 : 2 Marks]

1.9 What is the converse of the following assertion? I stay only if you go

(a) I stay if you go

(b) If I stay then you go

(c) If you do not go then I do not stay

(d) If I do not stay then you go

[2001 : 1 Mark]

1.10 Consider two well-formed formulas in propositional logic

F_1: $P \Rightarrow \neg P$

F_2: $(P \Rightarrow \neg P) \vee (\neg P \Rightarrow P)$

Which of the following statements is correct?

(a) F_1 is satisfiable, F_2 is valid

(b) F_1 is unsatisfiable, F_2 is satisfiable

(c) F_1 is unsatisfiable, F_2 is valid

(d) F_1 and F_2 are both satisfiable

[2001 : 1 Mark]

1.11 "If X then Y unless Z" is represented by which of the following formulas in propostional logic? ("$\neg$") is negation, "$\wedge$" is conjunction, and "$\rightarrow$" is implication)

(a) $(X \wedge \neg Z) \rightarrow Y$ (b) $(X \wedge Y) \rightarrow \neg Z$

(c) $X \rightarrow (Y \wedge \neg Z)$ (d) $(X \rightarrow Y) \wedge \neg Z$

[2002 : 1 Mark]

1.12 Which of the following is a valid first order formula? (Here α and β are first order formulae with x as their only free variable)

(a) $((\forall x)\ [\alpha] \Rightarrow (\forall x)[\beta]) \Rightarrow (\forall x)\ [\alpha \Rightarrow \beta]$

(b) $(\forall x)\ [\alpha] \Rightarrow (\exists x)\ [\alpha \wedge \beta]$

(c) $(\forall x)\ [\alpha \vee \beta\ ] \Rightarrow (\exists x)\ [\alpha] \Rightarrow (\forall x)\ [\alpha]$

(d) $(\forall x)\ [\alpha \Rightarrow \beta\ ] \Rightarrow ((\forall x)\ [\alpha] \Rightarrow (\forall x)\ [\beta])$

[2003 : 2 Marks]

1.13 Consider the following formula α and its two interpretations I_1 and I_2.

$\alpha : (\forall x)\ [P_x \Leftrightarrow (\forall y)\ [Q_{xy} \Leftrightarrow \neg Q_{yy}]] \Rightarrow (\forall x)\ [\neg P_x]$

I_1: Domain : the set of natural numbers
$P_x \equiv$ 'x is a prime number'
$Q_{xy} \equiv$ 'y divides x'

I_2: Same as I_1 except that P_x = 'x is a composite number.'

Which of the following statements is true?

(a) I_1 satisfies α, I_2 does not
(b) I_2 satisfies α, I_1 does not
(c) Neither I_2 nor I_1 satisfies α
(d) Both I_1 and I_2 satisfy α

[2003 : 2 Marks]

1.14 The following resolution rule is used in logic programming: Derive clause $(P \vee Q)$ from clauses $(P \vee R)$, $(Q \vee \neg R)$

Which of the following statemnets related to this rule is FALSE?

(a) $(P \vee R) \wedge (Q \vee \neg R) \Rightarrow (P \vee Q)$ is logically valid
(b) $(P \vee Q) \Rightarrow (P \vee R) \wedge (Q \vee \neg R)$ is logically valid
(c) $(P \vee Q)$ is satisfiable if and only if $(P \vee R) \wedge (Q \vee \neg R)$ is satisfiable
(d) $(P \vee Q) \Rightarrow$ FALSE if and only if both P and Q are unsatisfiable

[2003 : 2 Marks]

1.15 Identify the correct translation into logical notation of the following assertion. Some boys in the class are taller than all the girls

Note: Taller (x, y) is true if x is taller than y.

(a) $(\exists x)\ (boy(x) \rightarrow (\forall y)\ (girl(y) \wedge taller\ (x, y)))$
(b) $(\exists x)\ (boy(x) \wedge (\forall y)\ (girl(y) \wedge taller\ (x, y)))$
(c) $(\exists x)\ (boy(x) \rightarrow (\forall y)\ (girl(y) \rightarrow taller\ (x, y)))$
(d) $(\exists x)\ (boy(x) \wedge (\forall y)\ (girl(y) \rightarrow taller\ (x, y)))$

[2004 : 1 Mark]

1.16 Let a(x, y), b(x, y,) and c(x, y) be three statements with variables x and y chosen from some universe. Consider the following statement:

$$(\exists x)(\forall y)[(a(x,y) \wedge b(x,y)) \wedge \neg c(x,y)]$$

Which one of the following is its equivalent?

(a) $(\forall x)(\exists y)[(a(x,y) \vee b(x,y)) \rightarrow c(x,y)]$
(b) $(\exists x)(\forall y)[(a(x,y) \vee b(x,y)) \wedge \neg c(x,y)]$
(c) $\neg(\forall x)(\exists y)[(a(x,y) \wedge b(x,y)) \rightarrow c(x,y)]$
(d) $\neg(\forall x)(\exists y)[(a(x,y) \vee b(x,y)) \rightarrow c(x,y)]$

[IT-2004 : 1 Mark]

1.17 Let p, q, r and s be four primitive statements. Consider the following arguments:

P: $[(\neg p \vee q) \wedge (r \rightarrow s) \wedge (p \vee r)] \rightarrow (\neg s \rightarrow q)$
Q: $[(\neg p \wedge q) \wedge [q \rightarrow (p \rightarrow r)]] \rightarrow \neg r$
R: $[[(q \wedge r) \rightarrow p] \wedge (\neg q \vee p)] \rightarrow r$
S: $[p \wedge (p \rightarrow r) \wedge (q \vee \neg r)] \rightarrow q$

Which of the above arguments are valid?

(a) P and Q only
(b) P and R only
(c) P and S only
(d) P, Q, R and S

[2004 : 2 Marks]

1.18 The following propositional statement is

$$(P \rightarrow (Q \vee R)) \rightarrow ((P \wedge Q) \rightarrow R)$$

(a) satisfiable but not valid
(b) valid
(c) a contradictiction
(d) None of the above

[2004 : 2 Marks]

1.19 Let P, Q and R be three atomic propositional assertions. Let X denote $(P \vee Q) \rightarrow R$ and Y denote $(P \rightarrow R) \vee (Q \rightarrow R)$. Which one of the following is a tautology?

(a) $X \equiv Y$
(b) $X \rightarrow Y$
(c) $Y \rightarrow X$
(d) $\neg Y \rightarrow X$

[2005 : 2 Marks]

1.20 What is the first order predicate calculus statement equivalent to the following? Every teacher is liked by some student

(a) $\forall(x)$ [teacher $(x) \rightarrow \exists(y)$ [student $(y) \rightarrow$ likes (y, x)]]
(b) $\forall(x)$ [teacher $(x) \rightarrow \exists(y)$ [student $(y) \wedge$ likes (y, x)]]
(c) $\exists(y)\ \forall(x)$ [teacher $(x) \rightarrow$ [student $(y) \wedge$ likes (y, x)]]
(d) $\forall(x)$ [teacher $(x) \wedge \exists(y)$ [student $(y) \rightarrow$ likes (y, x)]]

[2005 : 2 Marks]

1.21 Let P(x) and Q(x) be arbitrary predicates. Which of the following statements is always TRUE?

(a) $(\forall x(P(x) \vee Q(x))) \Rightarrow ((\forall x P(x)) \vee (\forall x Q(x)))$
(b) $(\forall x(P(x) \Rightarrow Q(x))) \Rightarrow ((\forall x P(x)) \Rightarrow (\forall x Q(x)))$
(c) $(\forall x(P(x) \Rightarrow (\forall x Q(x)))) \Rightarrow (\forall x(P(x) \Rightarrow Q(x)))$
(d) $((\forall x(P(x)) \Leftrightarrow (\forall x Q(x))) \Rightarrow (\forall x(P(x) \Leftrightarrow Q(x)))$

[IT-2005 : 2 Marks]

1.22 Consider the following first order logic formula in which R is a binary relation symbol.

$$\forall x\ \forall y\ (\ R(x,y) \Rightarrow R(y,x)\ )$$

The formula is