MTL101: Important Previous Year Questions and Hints with special emphasis on post-minor topics

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1 Introduction

We have compiled some previous year questions which can help you practice for quiz 2 of MTL101. We do not intend to provide full solutions, to promote self practice. Some hints in tricky questions have been provided. So you can refer to them if you get stuck. Most of the question papers are available on the BSW website. Note that we have tried to include all papers with relevant questions on differential equations along with some extra topics that came along.

2 Question Papers to be practised

All efforts have been made to make this an exhaustive set of question papers as far as differential equations are considered. Note that Minor refers to Minor2. Obviously you know that.

- Minor 2015-16 Sem2
- Minor 2017-18 Sem1
- Major 2019-20 Sem2
- Major 2017-18 Sem1
- Major 2014-15 Sem2
- Major 2013-14 Sem2
- Major 2008-09 Sem1
- Major 2017-18 Sem2 (In a separate section on BSW site)

3 Hints for solving

Hints for some questions are as follows

1. Minor 2015-16 Sem2
    - Q1 Standard methods
    - Q2 Find eigenvectors
    - Q3 (a)Check definition (b) Nullity- Injectivity theorem
    - Q4 Look for an integrating factor
    - Q5 (a)Simple conditions (b) Solve the equation explicitly
2. Minor 2017-18 Sem1
    - Q1 Assume standard basis for $\mathbb{R}^3$ and then set $T(e_i) = v_i$ and assume a transformation with arbitrary constants. Solve for the constants.
    - Q3 Check for eigenvectors

- Q4 (a) Solve explicitly (b)Tricky one!
- Q5 Easy enough. Existence and Uniqueness
- Q6 No escape! Solve directly by known methods

3. Major 2019-20 Sem2

   - Q1 Follow known methods
   - Q2 Tagline here is : `on which existence and uniqueness theorem guarantee a unique solution`. No other methods allowed. So, it simplifies some of our work. I would suggest that you take a rectangle such that $|x - x_0| \leq b$ *and* $|t| \leq h$. Now, try out the continuity and differentiability conditions and then try maximizing the minimum.
   - Q3 Try reducing to exact form
   - Q4 (b) Do as the question states
   - Q5 Cauchy Euler equation

4. Major 2017-18 Sem1

   - Q1 System of Equations, simple
   - Q2 Cayley-Hamilton Theorem, obvious
   - Q3 Use method of undetermined coefficients

5. Major 2014-15 Sem 2

   - Q1 Prove f(t,y) is Lipschitz in y, rest is simple
   - Q2 The auxiliary equation is an Euler-Cauchy equation, find y_h, then use variation of parameters to find y_p.
   - Q7 System of Equations, simple
   - Q8 Basis, simple
   - Q9 Nullity of a transformation, simple

6. Major 2013-14 Sem 2

   - Q1 Find no of linearly independent vectors in the set.
   - Q2 (b) Observe that $T(V) \subseteq \ker(T)$ and use rank-nullity theorem.
   - Q3 Use $dim(W_1 + W_2) = dim(W_1) + dim(W_2) - dim(W_1 \cap W_2)$
   - Q4 Change of basis matrix, simple
   - Q5 Bernoulli Equation, simple
   - Q6 Basic properties of Wronskian, simple
   - Q7 Use method of undetermined coefficients

7. Major 2008-2009 Sem 2

   - Q4 (b) Picard's Iteration, simple
   - Q4 (c) Use method of undetermined coefficients
   - Q4 (d) Homogeneous equation, simple
   - Q4 (e) Similiar to Q2 of Major 2014-15 Sem2.

8. Major 2017-18 Sem2 (This might not be there on the main page for MTL101 on BSW but it is in a separate section)

   - Q2 Go by the question. The question will guide you to the answer
   - Q3 Standard question
   - Q4 Again refer to Picard's Approximation theory