



# Some experience in teaching multivariable Calculus for sophomores at ITB

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# About the Course



- 4 SKS, compulsory for Math Students
- Offered at 4<sup>th</sup> semester, after Calculus I & II and Elementary Linear Algebra
- Prerequisites for, among others,
  - \*Introductory Complex Analysis (5<sup>th</sup> sem.)
  - \*Probability Theory (5<sup>th</sup> sem.),
  - \*Mathematical Modelling (7<sup>th</sup> sem.), and
  - \*PDE (8<sup>th</sup> sem.)

# Contents



- Functions from  $\mathbb{R}$  to  $\mathbb{R}^n$
- Functions from  $\mathbb{R}^m$  to  $\mathbb{R}$
- Functions from  $\mathbb{R}^m$  to  $\mathbb{R}^n$
- Multiple integrals
- Line integral
- Surface integrals\*
- Green's theorem
- Stokes' theorem\*

[\*undelivered due to limited time]



# References

- W. Setya-Budhi,  
*Kalkulus Peubah Banyak*,  
Penerbit ITB, 2000.
- J.E. Marsden,  
*Basic Multivariable Calculus*,  
Springer-Verlag, 1993.

# Aim of the Course



- To broaden students' knowledge and to build their abilities in working with functions of several variables and in solving relevant problems.
- To enhance students' power in reasoning, making connection, and communicating.

# Delivery of the Course



- Conducted in two parallel classes, 47 were in my class
- Combination of (traditional) lectures and tutorials.
- Tutorials held at the end of each chapter.
- In tutorials, students were divided into groups. A set of problems were handed out to be discussed and worked out by the groups. Then one student from each group was asked to do a problem on the board.

# Evaluation



- Based on exams, quizzes, and homework.
- Exams were conducted twice, same weights.
- Quizzes were conducted after each tutorial.
- If a quiz could not be conducted (due to time constraint), a homework was assigned.



# An example from exams

- Explain why the function  $g(x,y)=xy$  is differentiable at  $(0,0)$  and determine a row matrix that represents the derivative.
- Write the Taylor polynomial of degree 2 for  $g(x,y)=xy$  around  $(0,0)$ .
- Apply the Second Derivative Test to  $g(x,y)=xy$  at  $(0,0)$ . What is your conclusion?



# From discussion sessions

- When discussing about the meaning of the limit of a function at a point, after asking several students, one student answered as follows:  
“limit  $f$  at  $c$  equals  $L$  means the value of  $f$  at  $c$  approaches  $L$ .” [Communication was not easy!]
- In general students are passive. They only said something when asked. Sometimes they didn't answer at all when asked. [Must be patient.]
- Many forgot what they have learned in the last semesters. [Review was a must.]

# Grading & Results

- A = 81-100 [14]
- B = 68-80 [7]
- C = 55-67 [6]
- D = 40-54 [8]
- E = 0-34 [12]



## Student's comments (1)

*“Pelaksanaan kuliah cukup menyenangkan, pembahasannya cukup mendetail dan mudah dimengerti. Catatan kuliah juga sistematis dan mudah dipahami.”*

## Student's comments (2)



*“Kami juga diberi kebebasan saat diadakan tutorial. Kami diperbolehkan untuk berdiskusi per kelompok untuk menyelesaikan suatu soal, dan menurut saya hal tersebut bisa memacu semangat kami untuk bisa, mengerti, dan saling melengkapi satu sama lain.”*

## Student's comments (3)

*“Pelaksanaan kuliah scr keseluruhan sdh baik, tapi rasanya monoton dan suara dosen yang datar membuat perkuliahan terkesan membosankan. Perkuliahan juga didominasi dg kegiatan mencatat. Terkadang saya harus memilih utk mencatat tapi kehilangan beberapa penjelasan atau memperhatikan sepenuhnya agar mengerti tetapi mencatat sekadarnya.”*

## Student's comments (4)

*“Materi kuliah Kalkulus Peubah Banyak sebagian mencakup materi kuliah Kalkulus TPB. Terkadang saya lupa dengan materi Kalkulus sehingga harus membaca Purcell lagi. Memang betul bahwa bila kita ingin sukses di mata kuliah KPB ini, belajar saya harus kontinu. Mengenai buku pegangan, menurut saya buku tersebut kurang komunikatif. Namun penjelasan dari dosen cukup membantu.”*

## Student's comments (5)



*“Kuis, PR, dan ujian menurut saya sudah pas dan cukup dengan kuis yang ada di tiap bab, PR yang menggantikan kuis dalam tutorial, dan ujian yang tidak terlalu banyak (2 kali ujian dengan bahan dibagi dua sama rata mengakibatkan bahan ujian yang cukup dan tidak terlalu berat).”*



## Student's comments (6)

*“...kegiatan belajar mengajar itu harus berjalan 2 arah, di mana dosen & mahasiswa saling aktif. Sebab jika hanya 1 arah saja (misal dari dosen), maka suatu waktu akan timbul suatu kejenuhan pada diri mahasiswa.”*