

## ELEN4000/4011 CONTROL RESEARCH GROUP MEETING MINUTES

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The following are always in attendance unless specified in 'Changes to Attending'.

### **Students:**

Jacob Riba (1442672)  
Sidwell Nkosi (1497963)  
Chizeba Maulu (900986)  
Tyson Cross (1239448)  
Sean Janse Van Rensburg (1073682)  
Darrion Singh (1056673)  
Haroon Rehman (1438756)  
Daniel de Barros (1036613)  
Malebo Maboko (672871)  
Lloyd Patsika (1041888)  
Thapelo Makhalanyane (875691)  
Sello Molele (0604606x)  
Nkululeko Sikhosana (1135124)

### **Lecturers:**

Prof. Anton Van Wyk

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The following document contains the minutes of all meetings for the ELEN4000/4011 Control Research Group for 2019.

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Date: 17 Sep. 2019  
Start Time: 9 AM  
End Time: 10:30 AM  
Venue: CM5, Chamber of Mines Building  
Chair: Daniel De Barros  
Secretary: Darrion Singh  
Approval of Minutes: Daniel De Barros  
Changes to Attending:  
    Prof. Anton Van Wyk (Absent)  
    Thapelo Makhalanyane (Absent)  
    Nkululeko Sikhosana (Absent)  
    Sello Molele (Absent)

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#### Proceedings

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1. Physical appearance of plane with assumed variables.
2. Clarification of the dynamics we are modelling?
3. What constitutes fixed wing?
4. We should choose a standard system and any extra common final model preliminary final scope by next monday.

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#### Key Notes

1. Bring questions to Prof. Van Wyk regarding proceedings of meeting.
2. Specifications are required in more detail.
3. D. Barros has offered to put together a preliminary project plan for the next meeting.
4. Group Google Drive has been set up by T. Cross.
5. Online meeting documentation set up by D. Singh.

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#### Announcements

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1. The next meeting will take place at Seminar Room, EIE Reception, 18 September 2019

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Date: 18 Sep. 2019  
Start Time: 8 AM  
End Time: 9:30 AM  
Venue: Seminar Room, EIE Reception, Chamber of Mines Building  
Chair: Daniel De Barros  
Secretary: Darrion Singh  
Approval of Minutes: Daniel De Barros  
Changes to Attending:  
    Sello Molele (Absent)  
    Malebo Maboko (Absent)

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Proceedings

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**General:**

1. ELO 7A/B noted as commonly unvisited sections in report, but regarded as important by external examiners.
2. Purpose of Design II is to bridge the gap between University and Industry.
3. Design process should start from high-level understanding of important processes, followed by a specific design choices that meets the problem criteria.
4. Design complexity should increase with time. Primary objective is to create a model that meets reasonable assumptions, and better design entails removing assumptions and catering to them.
5. Focus on how changes in one subsystem affects another subsystem i.e. cross-coupling of systems.
6. Prof. Van Wyk to confirm that Sello Molele is still part of Control Research Group.
7. D. Singh volunteers to be secretary for remnant of project.
8. T. Cross and S. Nkosi to facilitate meetings.
9. T. Cross proposes that D. Barros as lead of group; D. Barros accepts role.

**Regarding previous meeting:**

1. Choose the simplest possible variables when designing.
2. Quote regulations as motivation for design choices.
3. Minimum specifications of design as per the email from Prof. Van Wyk titled "Design Project 2019 - Control Group", 16 Sep. 2019.
4. Advised to scale down model as far as possible as to be viable in the timeframe given.
5. Acceptable to split group that subdivides workload into a single model per group.
6. Solutions **should not** be the same for more than one student.
7. Even if the results are the same, there must be distinct differences in the critical analysis.
8. Airframe ~ 6 degrees of freedom, propulsion system should be catered to various issues such as loss of remote control, weight distribution of frame is critical.
9. Be aware of research on propulsion; we may decide to simplify this as necessary.

**Current Meeting:**

1. Start drafting the outline as soon as possible. The outline provides context to project scope as well as helps in removing ambiguity.
  2. Think of short non-technical report should address the concerns of the layman, and meaningfully explain the aspects of the project.
  3. Review "Communications for the Engineer" if possible regarding the non-technical report.
  4. Format can be informative, for marketing (e.g. press release), educational.
  5. Consider the environment, sustainability, economic factors and their associated processes, not just the end outcome.
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## Key Notes

1. Common model to be confirmed by Monday 23 Sep.
  2. Simple modelling to take place before complex decisions.
  3. Sub-divide groups by Monday 23 Sep after everyone has researched the entire system.
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## Announcements

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1. The next meeting will take place at Seminar Room, EIE Reception, 23 September 2019 at 8 AM.

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Date: 23 Sep. 2019  
Start Time: 11:30 AM  
End Time: 12:10 AM  
Venue: Control Lab, Chamber of Mines Building  
Chair: Daniel De Barros  
Secretary: Tyson Cross  
Approval of Minutes: Daniel De Barros  
Changes to Attending:  
None

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## Proceedings

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1. MATLAB model of airframe and equations of motion:
  - a. Simulink toolbox good base for project
2. Report Structure
3. High level approach to project

## Key Notes

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1. Use of MATLAB toolbox discussed and approved
  2. Report needs clear explanation, cannot rely entirely on the MATLAB drone-simulink "black box"
  3. Report must demonstrate understanding
  4. Report Structure: 15 pages technical report @ 11pt: ~3000 words with figures/tables/plots
  5. Project must demonstrate experimentation and "tinkering" as evidence of engineering
  6. High level approach:  
"In front of you is an impossible task..."
    - a. make reasonable compromises and find appropriate scope
  7. Find MATLAB alternatives to be rigorous
    - a. Aerospace industry standards?
  8. Appropriate avoidance of unnecessary over-complexity
    - a. (not new physics research i.e. turbulence)
  9. Modelling Propulsion
    - a. No thermodynamics expert in our group
    - b. justification for constant mass and avoiding complexity of propeller/turbulence
    - c. Abstract to simple representative sub-system
  10. Energy Source
    - a. time of flight/weight
    - b. avoid hybrid system due to added complexity
  11. Assumption of steady trimmed flight acceptable
  12. Non-technical report: worth writing a preliminary draft already, before implementation inevitably focuses each individual engineer's attention on specific areas of the project.
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## Announcements

1. The next meeting will take place at Seminar Room, EIE Reception, 30 September 2019
  2. Prof. van Wyk will be away from October 4th to the 16th. His attendance to meetings during this time will be via Skype.
  3. Future meetings to be made as calendar invites by T. Cross
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Date: 30 Sep. 2019  
Start Time: 8 AM  
End Time: 9:30 AM  
Venue: EIE Seminar Room, Chamber of Mines Building  
Chair: Tyson Cross  
Secretary: Darrion Singh  
Approval of Minutes: Tyson Cross  
Changes to Attending:  
    Jacob Riba (Absent)  
    Sidwell Nkosi (Absent)  
    Daniel de Barros (Absent)  
    Malebo Maboko (Absent)  
    Sello Molelele (Absent)

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#### Proceedings

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1. Publish list of sub-groups to group drive.
2. Tyson has mentioned having completed a model that he is willing to share to be used as a base model, and requests that controller design with regards to the actuator be shared.
3. Find a specification sheet for the motor that shows its thrust response.
4. Sean has mentioned MAV research that shows decoupled actuator control.
5. For first cycle, assume step input, and assume them to be deterministic.
6. Thrust - 1st order, Actuators - gain/1st order, PID controllers for first cycle.
7. Two A/F models - longitudinal (normal force, axial force, pitch), lateral (yaw, roll, side slip)
8. Normal force and Side slip decided to be internal/remnant dynamics that need not be controlled.
9. Using body axes for frame of reference (instead of wind axes). Note the pro's and con's of using either.
10. Find previous reports to see Table of Contents.

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#### Key Notes

1. Use the simplified models proposed for the first design cycle.
2. If time permits, have two or three cycles.

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#### Announcements

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1. The next meeting will take place at Seminar Room, EIE Reception, 7 October 2019.
  2. Prof. van Wyk will not be attending this meeting, and may Skype into the meeting.
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Date: 7 Oct. 2019  
Start Time: 8 AM  
End Time: 9:30 AM  
Venue: EIE Seminar Room, Chamber of Mines Building  
Chair: Daniel de Barros  
Secretary: Tyson Cross  
Approval of Minutes: Malebo Maboko  
Changes to Attending:  
    Prof van Wyk (Absent)  
    Darrion -- (Absent)  
    Lloyd -- (Absent)  
    Malebo Maboko (Absent)

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## Proceedings

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1. Airframe: propose use of cited reference for SS matrix values (after derivation of EOM and simplifications/assumptions)
    - a. ARF60 with known coefficients cited from MA thesis
  2. Regarding report: in terms of contents (derivation of equations of motion)
    - a. Shall the entire derivation be included in main report or in appendix?
      - i. Summary in main report, with full derivation in appendix
      - ii. Main salient points explicitly included in main report
  3. Non-technical report: does it need to specifically be written as a marketing release?
  4. Ensure all ELOs are in main report
  5. Actuators -> external block, or included into the plant (i.e. in SS matrix)
  6. Electric Motor (cited reference uses combustion engine and fuel, i.e. not fixed mass)  
For simpler design, we propose using electric motor and batteries (i.e. fixed mass)
  7. Propellor modelling: non-linear, research mentions that it is complex to represent.
  8. Gift will put past papers onto Google drive for reference
  9. Sidwell proposal of thrust modelling as 2nd order function, with voltage -> propulsion
  10. Sidwell will publish the proposed model for propulsion as a 1st order system
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## Key Notes

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1. Get approval from Prof van Wyk for using cited values for ARF60 airframe model from MA thesis (on Google Drive)
  2. Past year papers onto Google Drive as reference
  3. Sidwell to publish 1st order propulsion model
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## Announcements

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1. The next meeting will take place at Seminar Room, EIE Reception, 14 October 2019.
2. Prof. van Wyk will not be attending this meeting, and may Skype into the meeting.

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Date: 14 Oct. 2019  
Start Time: 8 AM  
End Time: 9:30 AM  
Venue: EIE Seminar Room, Chamber of Mines Building  
Chair: Daniel de Barros  
Secretary: Tyson Cross  
Approval of Minutes:  
Changes to Attending:  
    Prof van Wyk (Absent)  
    Malebo Maboko (Absent)

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## Proceedings

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1. Discussion of last weeks work:
  2. Finding coefficients for lateral state space model: missing PSI (yaw) values for the ARF60
  3. Suggestion to use the ICENS model: both lateral and longitudinal coefficients provided. Also meets Class 1B UAV SA legal requirements.
  4. Focus on Longitudinal model emphasised
  5. Actuator time constant: 0.1s realistic from reference (Cook)
  6. Sean tried Pole Placement: pitch-angle to elevator (dominant pole theory).
    - i. Results in new TF, how to justify this new model?
    - ii. Daniel suggests a comparison to show the small change
  7. Propellor thrust modelling - TBD
  8. Non-linear model to test the controller on after development:
    - a. We do not have the data to construct a non-linear model
  9. Social/environmental aspect: use of UAVs in disaster management
    - a. Scientific mapping
  10. Ethical aspect: improving safety: not involved in the actual design of the airframe (using existing model). Usage of the hobby-level craft
  11. Success criteria: appeal to authority (citation) or proposed/evaluated as an engineer to be realistic.
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## Key Notes

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- Questions to ask Prof van Wyk:
    - How to get a non-linear model?
    - Should be focusing on this non-linear model? (Time aspect with remaining period before deadline for report)
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## Announcements

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1. The last meeting will take place at Seminar Room, EIE Reception, 21 October 2019.



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Date: 21 Oct. 2019  
Start Time: 8 AM  
End Time: 9:30 AM  
Venue: EIE Seminar Room, Chamber of Mines Building  
Chair: Daniel de Barros  
Secretary: Tyson Cross

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## Proceedings

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1. 6DOF freedom model: decoupled into two 3DOF model, linearized around small perturbation model in trimmed flight conditions
  2. Need to reapply the control system back to the non-linear model, to compare performance and evaluate the success of the design
    - a. How to get the required coefficients for this non-linear model?
  3. If unable to implement the Nonlinear system block (given limited access to full parameters of flight conditions and aircraft measurements):
    - a. Report should detail explanations of time estimates that would be required for developing/implementing Non-linear system that can be swapped out
  4. Process completed so far:
    - a. mathematical development of trimmed stable flight for linearization
    - b. choice of aircraft suggested by legislation
      - i. UltraStick 25e (or ARF60)
    - c. citation from MA or equivalent journal report/paper for actual numerical State Space matrix values for A, B
    - d. development of control system(s) for decoupled lateral/longitud. systems
  5. Engineering techniques: not just the use of papers, formulas, coefficients.
    - a. Must involve the investigation of the meaning of the values, and the iteration through design methods
  6. PID controllers:
    - a. showing insight into the behaviour of the chosen values (gain, derivative, integral values) could be a good example of engineering.
  7. Report should discuss what was possible, what was not possible (why, justify choices, explain context and prioritisation)
    - a. Time/project management analysis useful
    - b. Time breakdown per phase of the project (appendix?)
    - c. Projected estimations to show required time to complete the unfinished components
  8. Emphasise value of the process, achievements. Critical analysis of the problems and limitations, assumptions must be discussed.
  9. Submission links: Must check with the Course Coordinator
  10. MATLAB / code submission
    - a. GitHub repo
    - b. Flash drive submission
    - c. Codebase in appendix (if not too long)
  11. ELO appendix: a mapping to indicate the location and applicability of the individual ELO marking rubric within the report.
  12. Non-technical report: marketing material/interview/press release. A broad explanation of the project, addressed to non-technical readers.
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## Announcements

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Report Due at 12:00 on Friday 25th October

Thanks to Prof. van Wyk for all his help and advice