IIUC Vision 2030

A ROADMAP FOR EXCELLENCE

আন্তর্জাতিক ইসলামী বিশ্ববিদ্যালয় চট্টগ্রাম

International Islamic University Chittagong

combines quality with morality

IIUC VISION 2030

- A Roadmap For Excellence

Thinking Ahead 2017-2030

VISION, PASSION and COURAGE

An IIUC Publication
1 July 2017

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Foreword - Vision, Passion and Courage

Beginning from 1995 to present (2017) International Islamic University Chittagong has continued to mature into a university of higher education that successfully prepares students from diverse backgrounds from home and abroad for career and service anywhere in the world. Over the next decade or so, International Islamic University Chittagong will seek faithfully to be the first choice university in Bangladesh for students, faculty, and staff.

To steer IIUC from its current status to top national and then to regional class (on way to world-class) University is definitely a huge task which is both complex and lengthy. Nevertheless the opportunity is there but it would require Vision, Passion, and Courage to attempt to innovate further and to create a new and improved learning culture in the year 2030 from the present one.

The development of a strategic roadmap envisaged as the present VISION 2030 for the next decades or so for International Islamic University Chittagong is important for many reasons. In fact a strategic roadmap would guide a university toward achieving its long-term results, while keeping with the mission and guiding principles.

To achieve such excellence IIUC requires a strong, contemporary, well-maintained adequate infrastructure, an effective and responsive administration for leadership, and outstanding staff who work together toward common goals and objectives of IIUC. 'Attaining academic excellence demands the recruitment and retention of excellent faculty who are committed to outstanding undergraduate and graduate teaching as well as cutting-edge research. These two dimensions of excellence are mutually reinforcing. Without operational excellence, even the best faculty will not realize their potential, and without outstanding faculty, even the best infra-structure, staff, organization and processes will fail to produce excellence.'

In order to fulfill such VISION 2030 the present Roadmap has been prepared for IIUC. I must stress that the Board of Trustees must learn from the past of IIUC to build on its future. They should have a clear VISION, PASSION and COURAGE to materialize the dream in the path of excellence outlined in the Booklet.

I believe that sharing our strategic roadmap with our staff, stakeholders and colleagues will encourage open communication and ensure we are on the right track to meet the needs of our country and international communities. The dream-concept may then become reality through such roadmap.

Finally I should acknowledge several sources including some renowned universities of the world and websites from which several pictures and many of the ideas are used.

Kumira, Chittagong
1 July 2017

A K M Azharul Islam
Vice-Chancellor
International Islamic University Chittagong

In the name of Allah, the Most Gracious, the Most Merciful

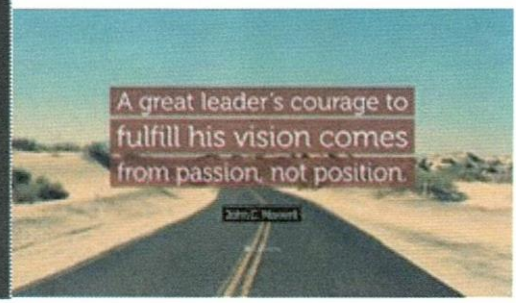
IIUC – Background in Brief

International Islamic University Chittagong (IIUC) is one of the top graded government approved private universities in Bangladesh. Having fulfilled the requirements as laid down in the Private University Act of 1992, and after obtaining the necessary clearance from University Grants Commission (UGC), and the permission of the Government of Bangladesh (GOB) through the Ministry of Education, Islamic University Chittagong (IUC) started functioning from February 11, 1995. The credit for the idea of establishing this University goes to the Islamic University Chittagong Trust (IUCT) for fulfilling the dream of the great philanthropist Maulana Maniruzzaman Islamabadi.

IIUC framed its own Statutes, Ordinances and Regulations governing the manifold activities of IIUC - academic, administrative, financial, student welfare, discipline etc. as per the Private University Act 1992, 1998 and then the revised Act 2010. Statutory bodies formed under the provisions of the Act have since then been functioning.

Thinking Ahead 2017-2030

VISION, PASSION and COURAGE



Chapter 1

IIUC – FUNDAMENTAL PRINCIPLES AND VALUES, MISSION AND VISION

1.1 Introduction

What shall our vision be for IIUC as we prepare for its **Vision 2030**, and how ought we to advance over the next decades? What we aspire to in a dynamic and shrinking world in which education and the creation of knowledge will play an even greater role?

A University always looks to the future to serve and develop local, national and International communities by creating purposeful knowledge and research, confident and creative graduates and a dynamic and engaged staff team.

IIUC's core missions in the path of excellence are **teaching, research, knowledge transfer and international outlook** which are the basis for judging World Class universities as in The Times Higher Education World University Ranking.

1.2 Fundamental Principles and Values

The following fundamental values will steer our actions and are a prerequisite to fulfilling the purpose of the university:

- Intellectual and ethiçal integrity,
- Rights and dignity of all persons,
- Mutual respect, kindness and purpose in all we do,
- Personal and institutional responsibility and accountability,
- 'Working to make a difference in the civic life of our communities and developing the combination of knowledge, skills, values and motivation to make that difference'.

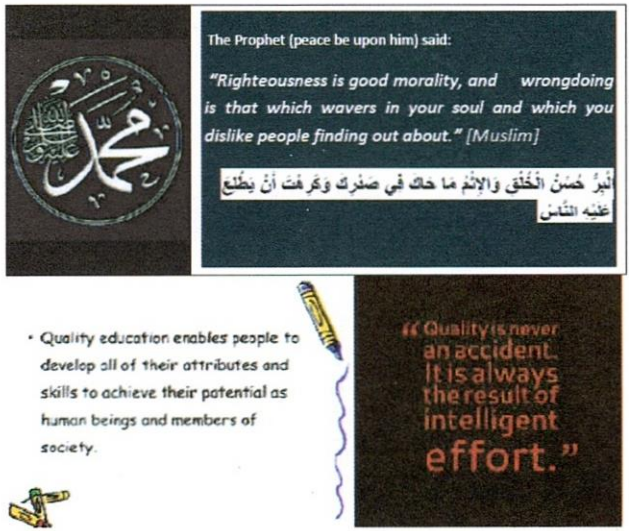
Further Values

- Small class sizes and a high level of student/faculty interaction;
- A learning environment that develops and promotes the skills of inquiry, reflection, critical thinking, problem-solving, innovation, teamwork, and communication in students;
- State-of-the-art facilities & technologies that enhance the learning environment;
- A diversity of students, faculty, staff that promotes a balanced exchange of ideas;
- A faculty recognized for their professional expertise and quality of instruction;
- A staff committed to the highest quality of service to IIUC community;
- A vibrant and varied campus setting that values diversity and diverse activities, and encourages involvement and interaction outside the classroom;
- A culture committed to integrity.

1.3 Mission and Vision

The Mission of the University is to produce through the pursuit of education properly trained up manpower to contribute to socio-economic development and moral upliftment of the society and to cultivate in our students expertise as well as ethical sensitivity, intelligence and an ability to think independently beyond their areas of study, so that they can sustain justice in all walks of life.

The Vision of the University is to offer nationally competitive and internationally recognized opportunities for learning to make this University as the Centre of Excellence in different areas of scholarship, like Shari'ah and Islamic Studies, Business Studies, Social Science, Science & Engineering, Arts & Humanities, Law, and such other faculties that will be introduced in future. Its door is open to the admission seekers from all over the world, regardless of race, region and religion. This university cherishes the dream of becoming one of the highest seat of learning and creator of knowledge in the South East Asia.



1.4 Objectives of the University

a. To create a new generation of competent youths, who will be equipped with academic excellence, professional expertise and adorned with moral height.
b. To follow a policy of continued Modernization of Knowledge and academic curricula in different disciplines of education so that its students can imbibe the true spirit of religious value as an effective guiding principle in their profession and daily life.

Motto of the University is to "Combine Quality with Morality"

Chapter 2

CURRENT STATUS WITH FACILITIES OF IIUC

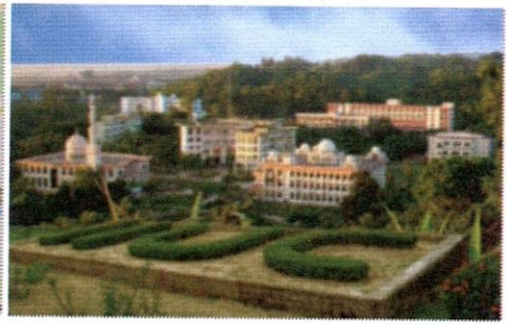
2.1 Campus with Existing Facilities

IIUC campus at Kumira includes about 43.031 (digital survey till 12 Dec 2014) acres of land with a sizable area full of different kinds of plants and trees, gardens, courtyards, spaces covered with grass, hill-side, woodland, athletic fields, small canal. A digital survey map of the campus is given at the end of this booklet.

Currently 40 small and large buildings (with 4 under construction) include Administrative, Academic & Library buildings, Central Masjid, Student Halls of Residence, Staff Quarters/ Teachers' Dormitory, Health Center, Post office, Water treatment plant and several service centers. For transport and other services IIUC has 24 big Buses, 5 AC Coasters, 15 double decker BRTC buses (plus dozens other hired buses) for transport of student academic and non-academic staffs. There are also 14 small cars, 2 microbuses and 2 ambulances.

Campus location

Partial view of IIUC campus



The University is home to about 11,000 (including about 200 foreign) students and over 400 academic staff (with ~25% Adjunct), 330 non-academic staff and 90 security guards.

Female zone/complex: The Female complex in the south campus consists of 3 large buildings that house class rooms, laboratories and office accommodation.

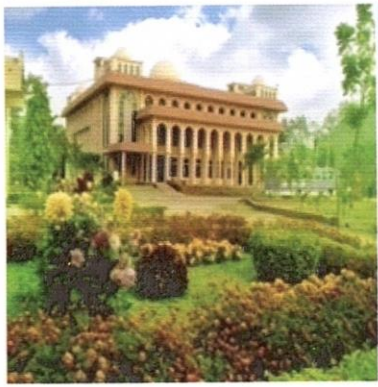
Here are some photos showing several existing IIUC buildings and facilities:

1. Administrative Building

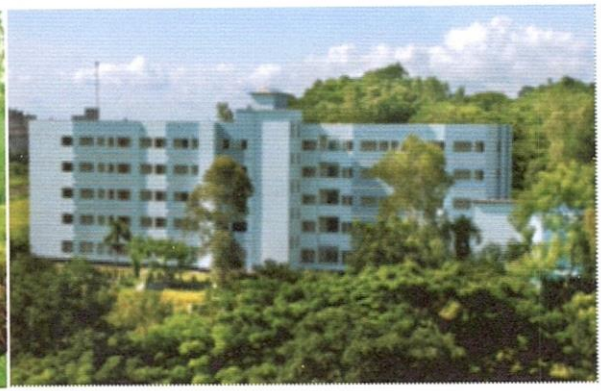
2. An internal Road besides buildings

3. Partial view of IIUC from above

4. Central Auditorium (distant view)



5. Distant view of Central Library



6. Science & Engineering building-1 (2nd bldg under construction)

7. Business Faculty

8. Academic Building – 1 (male)

9. Academic Building – 4 (male)

10. Academic Building – 7 (male)

11. Female Academic Building-1

12. Female Academic Building-2

13. Female Academic Building-3

14. Teacher's Dormitory

15. Partial back view of Cenral Cafeteria (upper floor Expansion in progress)

16. Water purification plant

17. Student Hall – 2

18. Student Hall-7

19. Roadside view of part of Central Masjid Complex

20. Playground beside Central Auditorium

21. Law Faculty and Central Library (partial) behing IIUC's 2nd Gate of Entrance

2.2 Current Academic Programs and Facilities: Faculties, Departments etc

The following academic programs are currently running

Undergraduate Programs:

1. Bachelor of Arts (Hons.) in Our'anic Sciences and Islamic Studies (QSIS)
2. Bachelor of Arts (Hons.) in Da'wah and Islamic Studies (DIS)
3. Bachelor of Arts (Hons.) in Science of Hadith and Islamic Studies(SHIS)
4. Bachelor of Science in Computer Science and Engineering (CSE)

5. Bachelor of Science in Electronic and Telecommunication Engineering (ETE)
6. Bachelor of Science in Electrical and Electronic Engineering (EEE)
7. Bachelor of Pharmacy (B. Pharm, Hons.)
8. Bachelor of Business Administration (BBA)
9. BSS (Hons.) in Economics & Banking
10. Bachelor of Arts (Hons.) in English Language & Literature (ELL)
11. Bachelor of Arts (Hons.) in Arabic Language & Literature (ALL)
12. Bachelor of Laws (LL.B, Hons.)

Bachelor of Science in Civil Engineering - Approved by UGC – currently not offered
Chinese Language Certificate Course (in association with Chinese Institute)

Visit: https://www.iiuc.ac.bd/undergraduate-programs/ for more details.

Graduate Programs

1. Master of Arts in Our'anic Sciences and Islamic Studies (MQSIS)
2. Master of Arts in Da'wah and Islamic Studies (MDIS)
3. Master of Arts in Science of Hadith and Islamic Studies (MSHIS)
4. Master of Business Administration (EMBA for Executive & RMBA for Regular)
5. Master of Bank Management (MBM)
6. Master of Arts in English Language and Literature (MA in ELL, Preli. & Final)
7. Master of Arts in English Language Teaching (MA in ELT)
8. Master of Laws (LL.M, Preli. & Final)
9. MSc. in Computer Science and Engineering (MCSE)
10. MSS in Economics and Banking (MEB)

Master Science in Pharmacy (under process)
PGLIDS program

Visit: https://www.iiuc.ac.bd/graduate-programs/ for more details

2.3 University Ranking

According to Webometric Ranking (the only available ranking system that uses all the universities of the world) IIUC ranks 24 in the country ranking (out of 115 public & private universities), 5738 in the world (out of 26340 universities). Source: Jan. 2017 Edition

Chittagong-based (8 Private + Intern. Women) University Ranking:

University (Private)	Country ranking (Total = 115)	World ranking (Total = 26340)
IIUC	**24**	**5738**
Asian Univ for Women	45	10418
Premier University	59	13907
Southern University	63	14393

East Delta University	69	15652
Port City Intern University	86	19104
USTC	88	19271
BGC Trust University	107	22552
Chittagong Independent	-	-

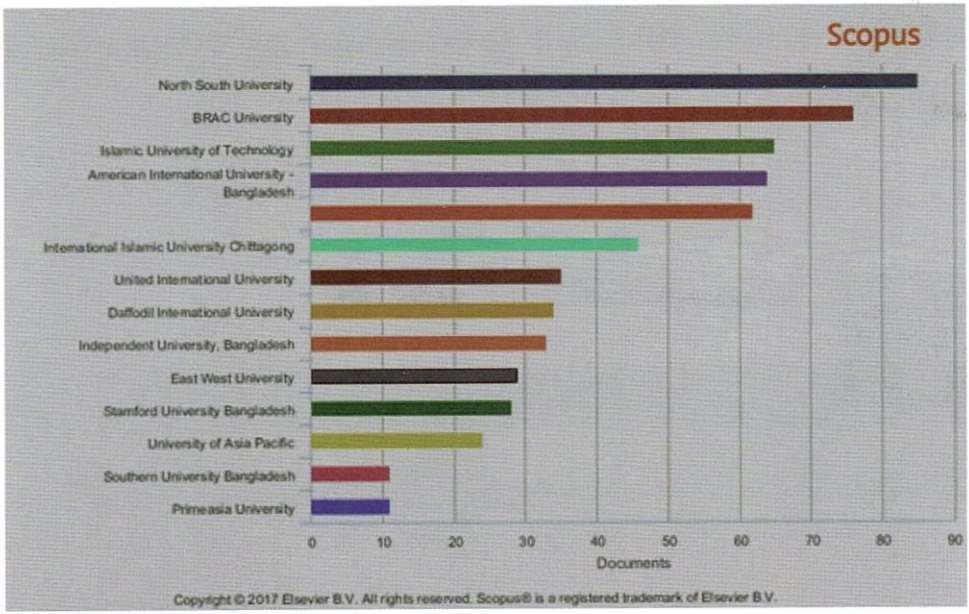
See Appendix -1 for "World University Ranking".

Or may visit: http://www.webometrics.info/en/node/178 ; http://www.webometrics.info/en/Asia/Bangladesh%20

IIUC's Research Ranking by Scopus

Scopus is the largest abstract and citation database of peer-reviewed literature: scientific journals, books and conference proceedings. Delivering a comprehensive overview of the world's research output in the fields of science, technology, medicine, social sciences, and arts and humanities, Scopus features smart tools to track, analyze and visualize research.

Publications from Top private universities + Islamic University of Technology (Scopus Data)



Visit:http://www.scientificbangladesh.com/en/news/scientific-publications-with-bangladeshi-affiliations-in-2016-in-scopus-indexed-journals#.WWyulrhX1qA

Position of Top Private University (Ranking by Scopus)

1. NSU	2. BRAC	3. AUST	5. IIUC
6. UIU	7. DIU	8. EWU	10. Stamford
11. UAP	12. SUB		

Watch Video: YouTube

Visit Link

1. **The Beauties of IIUC Campus (Full campus video documentary)**
   https://www.youtube.com/watch?v=ypSAfC16SsY

Creative Makers Studio

Published on Mar 16, 2017

International Islamic University Chittagong is known as the largest private univer sity of Chittagong. The campus is full of natural beauties.

2. **International Islamic University Chittagong – IIUC**
   https://www.youtube.com/watch?v=_SS9tCd_7wY

Didarul Islam Piash

3. **iiuc news_cplus news**
   https://www.youtube.com/watch?v=uvWEAm2xDnA

Cplus Tv

4. IIUC এর নিজস্ব বিশাল ক্যাম্পাসে সব কিছু-pro vc YouTube - YouTube
   https://www.youtube.com/watch?v=_GKbZ7X9i-s

Aug 12, 2016 ... IIUC এর নিজস্ব বিশাল ক্যাম্পাসে সব কিছু- pro vc YouTube ... **IIUC Human Chain against Terrorism**- Voice of Pro VC & students-MRWC90 ...

Md. Raihan W. C.

Chapter 3

INTO THE FUTURE – IIUC VISION 2030

Plan for IIUC: Learning from the Past to Build on the Future

3.1 Building on a Tradition of Excellence

As we celebrate the 21st anniversary of IIUC's establishment as a university, we can take pride in its tradition in the path of excellence.

Path of excellence is the foundation for our success till date and it is based on our key distinguishing characteristics: a distinctive university with moral value, a commitment to student engagement and learning, a culture driven by research and innovation and a commitment to civic engagement.

In a resource-constrained environment, we will need to focus our growth in those areas where we choose to develop a nationally and internationally recognized critical mass of excellence.

3.2 IIUC Vision 2030

- To be amongst the top universities in the country and become the centre of excellence in the South East Asia in learning, teaching, research and innovation driven by social needs and using state-of-the-art facilities and technologies.

- IIUC aspires to university standing of the highest grade, but it fixes no upper limit to its educational endeavor.

To achieve this vision IIUC will ensure:

- An adaptable, flexible approach to learning that allows students to choose from multiple and potentially integrated pathways to achieve bachelors, and postgraduate degrees.

- A highly qualified faculty that excels in teaching, research and interacting with students.

- A curriculum, often bridging education and professional programs, that successfully prepares students from diverse backgrounds for the 21st century in the areas of personal and social responsibility, ethics, and intercultural/global learning.

- Continued investment in state-of-the-art facilities and technologies that enhance the learning environment for every student.

- A wide array of academic programs that are improved on an on-going, continuous basis for quality and relevance to World's needs in the context of an ever-changing world.

- **Good Governance, Transparency and Accountability:** An administration that uses human and natural resources wisely, ensures transparency and accountability, embraces excellence, is committed to shared governance, and is focused on the future.

To achieve the vision and mission as a university, IIUC must focus on several key areas and goals as enumerated below.

3.3 People and Community

Goal: To recruit and retain a diverse group of exceptionally talented students (local & foreign), faculty (local & foreign) and staff and to support them in ways that allows them to achieve their higher potential.

As for Community the 'Goal' will be: To establish IIUC as a recognized cornerstone of the community, committed to the sustainable social, cultural and economic development of our region and our nation.

3.4 Quality – Academic Programs, Teaching, and Learning

Goal: We set the goal to offer programs in teaching, research and support of such quality as to place us in the top position in the country as judged by peer evaluation (such as National Accreditation Council - see UGC'c IQAC directives).

The University's success is dependent on the quality of its scheduled activities and the resulting accomplishments of students, faculty and staff. As a mid size university IIUC face the challenge of carefully selecting those areas in which we choose to develop and excel, while ensuring that its students receive the highest-quality education possible. So IIUC must carefully build the areas of focus, with the choice of disciplines and specialties – all of these should be driven by our strengths and aspirations in teaching, research and scholarship, and by the evolving needs of society.

A rich and diverse set of academic programs across the full range of disciplines (initially of societal needs) is essential to our reputation in teaching and research. New programs are developed when there is a demonstrated societal need and value, student demand, faculty expertise, and the capacity for IIUC to become a leader in the field. The quality of teaching and learning in our academic programs should be enhanced.

Faculty: The quality of IIUC endeavors is determined by the quality of its faculty and their scholarship in teaching, research, and creative and professional activity. IIUC's success is also dependent on its faculty's commitment to excellent teaching and learning.

IIUC should give priority in retaining its exceptional faculty and to provide an environment that supports the achievement of their academic ambitions.

3.5 Research and Center for Research and Publication (CRP)

Giving proper focus on research, scholarship and creative activity differentiates a university from other universities. The ideas, discoveries and innovations emanating from a university profoundly affect the well-being of society as well as its international competitiveness. Areas of focus in teaching, research and scholarship will be determined by departments, faculties, based on following criteria:

a. Research Facilities, Funding and Research Prizes (role to be played by IIUC-CRP)

One important factor that affects the dissemination of the culture of scientific research among academic staff is the availability of facilities and funds (where necessary) enabling academic concepts and ideas to be explored, investigated, and realized through conducting research.

IIUC need to encourage its academic staff by all possible means. Such means of encouragement are:

- Individual research for career building and for promotion,
- Funding for research needing extra resources,
- Prize for publishing in ISI/Scopus ranked journals and other reputed journals,
- Prize for Winners of International Prizes/recognition for excellent research.

To encourage good publications Link annual increments in salary to publication by teaching faculty (particularly for Professors – because at present they don't need any more research publication for promotion).

A prime factor in ensuring funding is that would-be researchers are required to provide substantive evidence that the proposed work is eligible for publishing in ranked ISI journals or their academic status equivalents.

b. Conference Attendance

Conferences are venues for the exchange of knowledge and experience. IIUC should encourage its academic staff with high standard research work (substantive evidence that the work is eligible for publishing in ranked ISI journals or their academic status equivalents) to attend international conference to enable him to meet with prominent researchers and witness presentations of the results of the latest research and for possible collaboration in joint research.

IIUC should allocate fund through CRP for such types of activities by providing some initial cost (DA/Registration). For other cases encouragement via duty leave etc. may be granted following IIUC rules.

3.6 Library and Scholarly Information Services

In an age of digital modernization libraries continue to build on a proven track record of supporting the research culture and information needs on-campus.

As a center of learning, IIUC's library system should further be oriented for the future – flexible and responsive to academic needs, providing support for writing, studying, tutoring, career guidance and interdisciplinary learning. Spaces and services will continue to be customized to meet new challenges and library will create new opportunities for students and faculty. (See more in section 5.4)

3.7 Service-oriented Support Culture and Computing and Internet Access

Support Culture: IIUC's faculty, staff and students, as well as visitors to campus, depend on effective and efficient infrastructure and administrative support to ensure that they are able to achieve their goals. A support culture that is service-oriented, knowledgeable, committed and friendly builds both the productivity and the morale of our institution.

Computing and Internet Access: With the development of graphical user interfaces and access to worldwide information resources, demand for Internet access always seemed to outpace resources and policies of IIUC. At present IIUC provides both wireless and wired network access in several buildings. IIUC faculty, staff and students can connect to the internet in a variety of ways, from various locations in several labs, offices etc.

Access to the Internet and WWW at IIUC is to be provided to all students (both male and female) via labs in various academic areas, the Library, Computer Center and Halls of residence. Teachers and students should not be charged for computer access to services such as e-mail, library services, application packages, and the WWW.

3.8 Alumni Network and Convocation

IIUC with thousands of alumni around the world are its most valuable ambassadors. They are expected to play a key role in promoting the university's reputation and quality. IIUC must engage them effectively in the life and work of the university, which in turn will help improve our educational and research environments, and our ability to attract and retain the best students. (See Alumni in 'University Songbidhi')

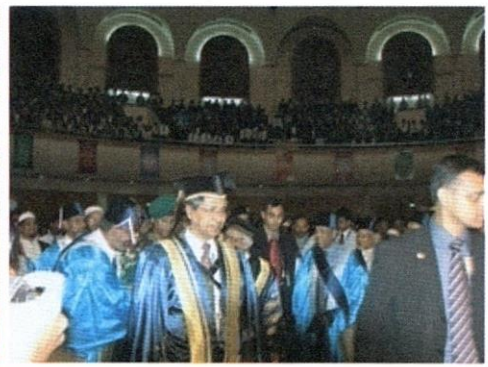
IIUC should make a global network with 27,000 IIUC alumni, who should be reachable by anybody through the network. An official initiative is to be undertaken for publishing a directory of the graduated students program-wise as to maintain a close contact with the alumni of IIUC. The webpage may be developed as follows:

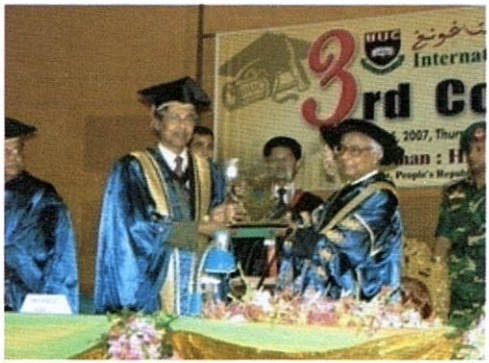
Alumni Network

- Home
- About Us
- IIUC Network
- Registration
- News & Events
- Gallery
- Contact Us

Convocation: Convocation is the university graduation ceremony to award degrees to students and honorary graduates. IIUC held 3 such ceremonies in the past. Usually, convocations are regularly held and degrees are awarded accordingly. But due to some adverse situations regular convocations could not be held despite arrangements. However IIUC should embark on a befitting strategy to hold Convocation on a regular basis in the years ahead.

Some pictures from past convocation





3.9 New Academic Programs

New academic programs should be proposed only for compelling reasons, as these require significant University resources. IIUC should continue to build on its mission of being a global university. Concordant with this goal, there should always be efforts to introduce new academic programs in the university. These programs should offer the opportunity for expanding IIUC's global mission as an institution by meeting educational needs in demand for today's workplace (in Bangladesh as well as in international scene), and have a secondary benefit of providing additional revenue to further the overall academic mission.

The method for proposing new academic programs in various faculties is similar to that for revising existing programs. But it is usually more complex since all new programs must be approved by different IIUC committees, Academic Council, as well as by the Bangladesh University Grants Commission.

Possible list of new programs for IIUC may be as follows:

- Civil Engineering (under process)
- Architectural Engineering
- Textile Engineering
- Development Studies
- International Relations
- Media Studies and Journalism
- Environmental Science and Disaster Management
- Health Science

Chapter 4

EXCELLENCE INITIATIVES

4.1 Building a World-Class University through Infusion of Quality

To build a World-Class University is a huge task which is both complex and lengthy. But necessary Vision, Passion, and Courage are required to innovate further and to deliberately create a new and improved learning culture from the present one.

In improving performance and quality by fulfilling conditions of BAETE & UGC Accreditation policy would help overall system to move up on the quality spectrum.

Priorities and University-Level Initiatives

- **Students First**

  Provide an inclusive and engaged living-learning environment where all students thrive and graduate as informed citizens committed to life of impact:
  - Enhance and expand student success program systematically to improve retention and graduation rates
  - Adopt a student engagement strategy that enhances learning through increased participation in high-impact experiences,
  - Align the undergraduate educational experience to focus on purposeful and essential learning outcomes.

- **Distinctive IIUC through talented Faculty and Staff**

  Drive innovation, idea generation through top-tier academic and research programs including recruitment and support of talented faculty and staff,
  - Build a culture of research and innovation.

- **Regional and Global Competiveness**

  Advance IIUC's impact and reach as leading regional/international University,
  - Increase enrolment of international students and enhance their engagement in campus life,
  - Enhance the internationalization of the university through programmatic and partnership engagement.

- **Regional Impact**

  Serve as the innovative engine and engaged partner to meet community needs and enhance quality of life in the country and region
  - Enhance and advance systematically university/community engagement efforts

- **Organizational Stewardship**

  - Ensure a culture of continuous improvement and the efficient stewardship of university resources and infrastructure
  - Build alumni and philanthropic engagement commensurate with national peer institutions
  - Establish a culture of sustainability and continuous improvement

See also Chapter 3 & Sections 4.2 & 4.3 below

4.2 Teaching, Learning and Resources

Metric or Standards of measurement by which efficiency, performance, progress, or quality of the university can be assessed are occasionally based on:

- Highly qualified academics/Faculty with PhD and experience
- Standard Library & Lab facilities
- Standard Sports & Extra-curricular activities
- Teacher Student ratio with an emphasis on permanent faculty

4.3 Online Teaching Efficiency Rating (TER)

The motto of IIUC is to **"Combine Quality with Morality".** The role of the teachers and their efficiency can never be neglected in ensuring the Quality Education. We do believe that it will bring a positive impact in attaining this noble objective in the long run.

This rating is undertaken for each Semester at IIUC. It gives the students chances for giving their opinion about the instructor of each course and it gives the teachers chances for continuous self-assessment and improving their efficiency level. It is also helpful for the University to upgrade its standard of education.

The students fill in the TER Form online on questionnaire about the parameters:

Q1. Mastery over the subject & clarity of presentation
Q2. Communication skill
Q3. Preparation of classes with updated information
Q4. Attention to individual students & role to develop their morality
Q5. Punctuality
Q6. Giving Tests & Assignments
Q7. Making arrangement of Make-up classes
Q8. Personality & Morality
Q9. Temperament and Behavior
Q10. Being absent without prior information

Grading Score & point

Score	Grade	Grade Point
90.00 - 100.00	Excellent	5.00
80.00 - 89.99	Good	4.00
70.00 - 79.99	Satisfactory	3.00
60.00 - 69.99	Weak	2.00
50.00 - 59.99	Unsatisfactory	1.00

The evaluation report contains a graph in addition to course-wise score. It gives the score in each of the parameters (Q1 to Q10) showing the performance (Excellent to Unsatisfactory) of the course teacher.

4.4 Research Productivity and Impact

Research reputations are based mainly on publications and their citations. Citation impact quantifies the citation usage of scholarly works. It is a result of citation analysis or bibliometrics. Among the measures that have emerged from citation analysis are the citation counts for an individual article, an author, and an academic journal.

One of the most basic citation metrics is how often an article was cited in other articles, books, or other sources (such as theses). Citation rates are heavily dependent on the discipline and the number of people working in that area. For instance, many more scientists work in neuroscience than in mathematics, and neuroscientists publish more papers than mathematicians, hence neuroscience papers are much more often cited than papers in mathematics. Similarly, review papers are more often cited than regular research papers because they summarize results from many papers. This may also be the reason why papers with shorter titles get more citations, given that they are usually covering a broader area. (source: Wiki)

4.5 Enhance SDSWD Activities

The duties and activities of the Staff Development & Student Welfare Division (SDSWD) have been described in chapter II of "IIUC Songbidhi" (Section D) in details.

Among these the following activities are to be enhanced in future:

i. To arrange Student Welfare Committee Meeting for preparing lists as per IIUC rules for financial award to students in regard to Sibling Waiver, SSC/HSC result Waiver, Wards of Freedom Fighter and Needy students.

ii. To arrange view-exchange programs and Talent Development Workshop in each semester about the academic progress with the student representa tives, newly selected students of scholarship holders and wards of Freedom Fighters.

iii. To bring/invite foreign students the following procedures shall be followed:Maintaining Contact with different countries/Organizations to bring/invite Foreign Students, Processing & Mailing offer letters to New Foreign students of different countries in each semester, Issuing Release Letter to Immigration & Airport for Foreign Students, Issuing Recommendation Letter to different Embassy for issuing visa for Foreign Students and Protocol to New Foreign Students at Airport.

iv. To arrange Orientation for New Foreign Students, Day-long Workshop for Foreign Students and Farewell to Foreign Graduate Students in each Semester.

v. To do all the necessary formalities in regard to Assisting, Mailing and Supervising IIUC students for Credit Transfer to foreign universities and exploring opportunity for Credit Transfer also.

vi. To take necessary steps for Signing of MoU with different foreign universities & organization, Processing Applications of students with Full Scholarship (for Honours, Masters & PhD) in Foreign Countries, Visiting Foreign Country (if necessary) and for correspondences with different foreign universities for Higher Studies for Faculty members.

vii. To take necessary steps for Printing & Publications of IIUC Diary, Desk Calendar & Quarterly Bulletin as well steps for distribution of the above articles.

viii. To provide opinion regarding study leave and higher study of Academic & Administrative staff as per SDC rules and to take steps to execute Bond for teachers.

4.6 Activities to Boost IIUC's Web Visibility

Institutional visibility is critically important as it is influential in driving up (or down) scores in the reputational surveys. Whether we like it or not, the branding of an institution plays a pivotal role in shaping reputation. A clearly articulated strategy to boost institutional visibility is a priority.

Universities need to focus on research output and impact. University leaders need to draw up a long-term strategy to generate the levels of research output required for consideration for rankings. This may include targeted professional development programs, among many other initiatives.

Strategies to improve Web ranking are given as follows:

For IIUC Faculty and Researchers

- Publish more research – to improve Excellence Rank (ref: Webometric Ranking)
- Publish great contents on the web (namely in Digital Resources) – to improve Impact Rank
- Create a Google profile

  How to create your Google Scholar profile – 7 steps with Screenshots, Visit https://www.iiuc.ac.bd/google-scholar-profile/

  Make sure everyone keeps their Google Scholar Citations Profiles up to date.
- Publish in better impact factor Journals
- Publish in OAJ (Open Access Journals)

Important: Quality research output, including both formal and informal scholarly communication. Provide Links of bibliographic citations that would involve third parties with university activities.

- All IIUC Journals are to be uploaded in BanglaJOL
- Upload all presentations, notes, papers, talks to Digital Resources (IIUC) https://www.iiuc.ac.bd/category/digitalresourcesiiuc/
- Start blog and publish contents in Digital Library/Digital Resources
- Adding metadata, weblog, Links, Web Hosting, groups on Yahoo and Google, Build Institute page on Facebook, Twitter, SlideShare, Researchgate, LinkedIn, Flicker, YouTube, iTunes, Open Course Ware (after consulting with ITD Division).

These are some examples of an array of initiatives that could work well for university wanting to improve its positioning in university rankings. (A. Calderon, University World News: 24 June 2016 Issue No: 419). Additionally in order to boost scores in the international research network, universities may be able to draw on their alumni who may be working in academia abroad.

Green web presence: Establish a user friendly "green" web presence on the IIUC homepage. An IIUC homepage "Green Link" is to be created which goes to a page that needs to be filled with environmental tips, links to blogs and other information including articles about IIUC's ongoing environmental and sustainability efforts and success stories!

Further Actions

- **Attend international conferences (Section 3.5 b)**
  Attending international conferences is a great way to get IIUC's name out there. Not only is it an opportunity to learn from other universities around the world in regards to academic research, marketing and recruitment, conferences are a sure-fire way to create international connections and foster relationships that could lead to eventual collaboration.

- **Develop university brand**
  In order to increase IIUC ranking and draw in more international students, we need a well-established brand identity. This could include simple things such as making sure IIUC website is live and up to date with relevant and correct information. In order to improve IIUC's international standing as a reputable university, we must first establish IIUC's brand as recognisable.

- **Create industry connections**
  These can be connections within IIUC's field of academic research, or local businesses and companies in the area. Creating lasting connections with other organisations will help to encourage more academic collaboration, which will in turn help to improve IIUC's academic reputation. This will help more of IIUC's students to find employment after they graduate.

4.7 Quality and Accreditation

a. UGC – IQAC

The UGC Accreditation Agency has set the standards of quality for a university. These are, in terms of performance, related to the educational processes and outcomes, covering the curriculum, teaching-learning evaluation, faculty, research, infrastructure, learning resources, organization, governance, financial well being and student services.

Institutional Quality Assurance Cell (IQAC)

The formation of the IQAC at IIUC: The University Grants Commission of Bangladesh (UGC) has established a Quality Assurance Unit (QAU) with a view to prepare the University to meet the External Quality Assurance and Accreditation requirements for Quality Assurance and Accreditation Council of Bangladesh (QAACB). In pursuance of the requirement of Private University Act 2010 an "Institutional/Internal Quality Assurance CEll (IQAC)" cell is formed at IIUC as per recommendation of 31st Academic Council meeting held on March 06, 2014 and approved in the 179th Syndicate meeting held on March 11, 2014.

The Objectives of the Cell: The main objectives of establishing IQAC at IIUC is to develop internal quality assurance systems and to prepare IIUC to meet the requirements for Quality Assurance and Accreditation Council of Bangladesh (QAACB).

The major functions of IQAC shall be as follows

i) Facilitate the mission and objectives of the university addressing national relevance and emerging global trends.

ii) Guide and assist the degree offering entities of the university to define program objectives.

iii) Develop standard and benchmarks for various academic and administrative activities of the university.

iv) Review existing procedures for further improvement.

v) Prepare QA documents and procedures for use within the university following specifications and guidelines provided in the IQAC OM.

vi) Encourage staffs to maintain professional code of conduct in accordance with the QAU guidelines and international practices and facilitate to maintain good practices in operations.

vii) Provide necessary supports to the study program offering units, i.e departments, faculties, institutes to conduct the self assessment, external peer review and implement QA process at programs level.

viii) Conduct schedule monitoring of implementation of policies, systems, processes and procedures.

ix) Facilitate to conduct institutional assessment.

x) Facilitate to approval of new program offering entity and new programs for existing entities using appropriate procedures.

xi) Develop a database for information regarding quality assurance which will be deliverable to all stakeholders.

xii) Prepare and procedure annual Institutional Quality Assurance Cell (IQAR) and monitoring report assessing the activities of IQAC and submit to the QAC. Develop an institutional QA strategic plan for every 5 years and ensures its implementation and monitoring of achievements.

xiii) Co-ordinate all QA related activities within the university.

xiv) Liaise with QAU and other external QA agencies.

xv) Organize the workshops, seminars and appropriate training for capacity building and promoting QA culture at all levels of the university.

xvi) Advise university management, faculty and department on QA and related matters.

xvii) Take initiative and lead to establish staff development center at the university.

xviii) Prepare the detailed budget of the IQAC and

xix) Conduct impromptu audit at any levels of the university if necessary.

b. BAETE BAETE Accreditation

Accreditation

- **Program of Study: B. Sc. in Computer Science and Engineering (CSE)**

  This program is a University Grant Commission Bangladesh (UGC) approved program. Besides, this program was accredited by the Board of Accreditation for Engineering and Technical Education (BAETE). BAETE has already completed the review processes for the renewal of the accreditation – Renewal of Accreditation is expected to be announced soon. Please visit the BAETE Accreditation page for details.

- **Program of Study: B.Sc. in Electronic and Telecommunication Engineering (ETE)**

  Approved by UGC. Application for IEB Accreditation of this program will be made soon (also see below).

- **Program of Study: B.Sc. in Computer & Communication Engineering (CCE)**

  The CCE program is a University Grant Commission Bangladesh (UGC) approved program. Later, a new program **"B.Sc. in Electronic and Telecommunication Engineering (ETE)"** was opened which has already been approved by the University Grant Commission Bangladesh (UGC).

  B.Sc. in Computer & Communication Engineering (CCE) is an accredited program of BAETE. IIUC will apply to the Board of Accreditation for Engineering and Technical Education (BAETE) in due time (as per BAETE policy) for the new program ETE also.

- **Program of Study: Bachelor of Science in Electrical and Electronic Engineering (EEE)**

  This program is a University Grant Commission Bangladesh (UGC) approved program. The team for accreditation from BAETE for this program is to visit IIUC soon (around August 2017).

- **Program of Study: Bachelor of Pharmacy (B. Pharm, Hons.)**

  This program is a University Grant Commission Bangladesh (UGC) approved program. Besides, the Pharmacy Council of Bangladesh (PCB) has accredited this program and confirmed to IIUC with a letter (**Ref : PCB/2150/(1)/06** on 16th of November 2016).

- **Program of Study: Bachelor of Laws (LLB Hons.) and Master of Laws**

  The programs are University Grant Commission Bangladesh(UGC) approved programs.

Chapter 5

PHYSICAL INFRASTRUCTURE

5.1 Build a Magnificent Campus

The construction of good academic infrastructure with the state-of-the-art facilities is an important part of education experience of learners. It 'requires vision, passion, and courage to attempt to innovate and to deliberately create a new and improved learning culture'. For this an energetic Board of Trustees set-up, a strong administrative leadership team, a well-thought curriculum, and highly qualified academics, the perceived beautiful campus will remain little more than an empty shell that embodies a waste of valuable resources.

The physical infrastructure is obviously the most visible part of a university. 'A lot of care should be given to the design and construction of impressive, state-of-the-art facilities, and rightly so. Good academic infrastructure is certainly an important part of the education experience of students, and researchers need adequate laboratories to carry out leading-edge scientific inquiries'.

5.2 Buildings – Main Component of Campus Infrastructure

Buildings, central equipment and utilities are all components of campus infrastructure that help students, faculty, and staff perform to their highest potential. Planning, maintaining, and optimizing campus infrastructure ensures uninterrupted and efficient operation.

In order to accommodate more academic programs with modern facilities and to provide residential facilities for teachers and non-academic staffs more building are needed to be constructed phase-wise. Future academic buildings should be planned in such a way that digital facilities, especially multimedia projector, good sound system and internet access are to be installed in selected class rooms.

Necessary facilities for the followings are required:

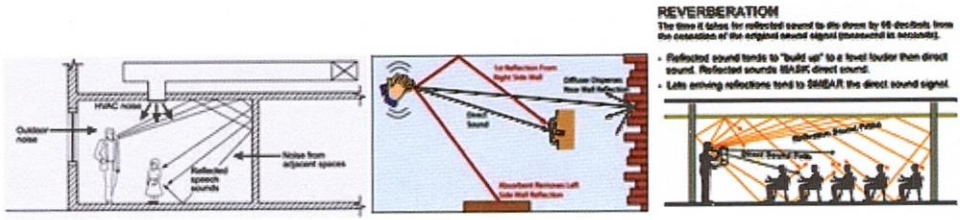
- CRP – office room along with Director' office room & research room with internet.
- IQAC office room along with attached director's room/office.
- Proctor office along with attached Proctor's room/office.

New administrative building when constructed may serve the above needs.

5.3 Design Lecture Rooms with Digital Facilities and Good Acoustics

A student's ability to hear and understand what is being said in the classroom is vital for learning. Unfortunately, this ability can be reduced in a noisy classroom. Poor classroom

acoustics occur when the background noise and/or the amount of reverberation in the classroom are so high that they interfere with learning and teaching. See Appendix-II

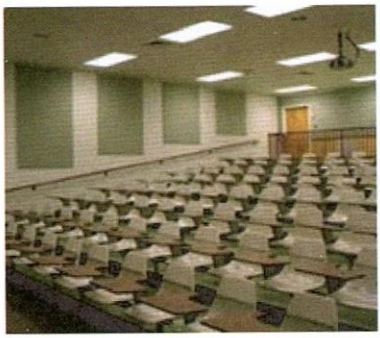


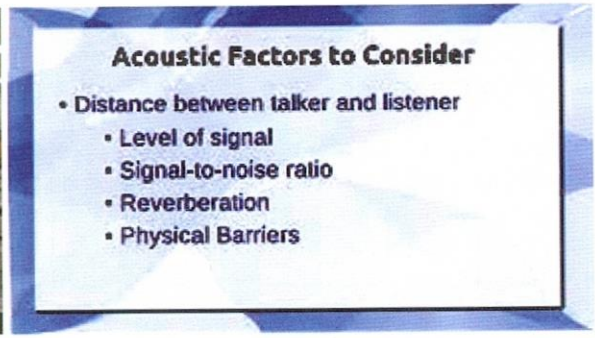
Picture credit: https://www.google.com/search?q=Reverberation+time+versus+classroom+size&client=firefox-b&tbm=isch&tbo=u&source=univ&sa=X&ved=0ahUKEwif-7Lc38nUAhWKPI8KHX8dCvQQsAQIVA&biw=1280&bih=689#imgrc=P1xioo4gwZcTSM :

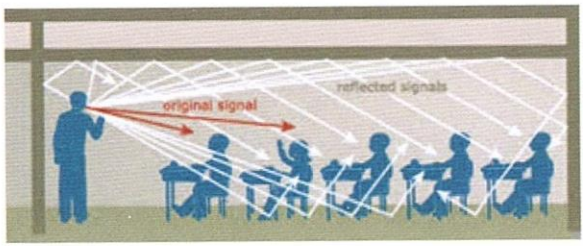
Acoustic Prerequisite

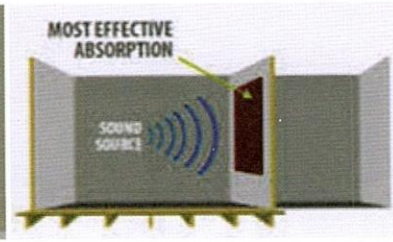
Quiet in the classroom enhances the learning environment through better acoustics. To provide classrooms that facilitate better teacher-to-student communication, class rooms need a minimum acoustical performance prerequisite. To attain it, one must meet two requirements:

First, design classrooms and other core learning spaces to include sufficient sound-absorptive finishes to meet the maximum reverberation (example: 0.4 - 0.6 s for classrooms depending on size).







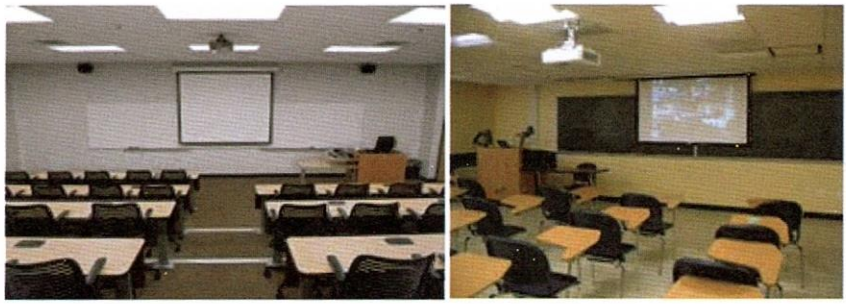


Second, meet a maximum background noise level from AC systems (Ceiling FAN noise level might be in excess) in classrooms and other core learning spaces of 45 dBA.
One can comply with the first requirement in one of two ways:

Confirm that 100% of all ceiling areas (excluding lights, diffusers, and grilles) are finished with a material that has a Noise Reduction Coefficient (NRC) of 0.70 or higher. Or, confirm that the total area of acoustical wall panels, ceiling finishes, and other sound-absorbent finishes equals or exceeds the total ceiling area of the room (excluding lights, diffusers, and grilles). All materials must have an NRC of 0.70 or higher to be included in the calculation.

In the case of classrooms and other core learning spaces, confirm through calculations that the spaces are designed to have a reverberation time in the range 0.4 – 0.6 sec (see Optimum Reverberation Time, p-62, Appendix-II)

The place for focused learning: Properly designed spacious, amphitheatre-style classrooms in the University provide the most conducive atmosphere for dynamic and focused discussions. The rooms should be augmented with **integrated audio-visual teaching aids for lectures, presentations etc (see pictures below).**



The 21st Century Classroom will be a place where students move up to beyond rote memorization skills to creation skills.

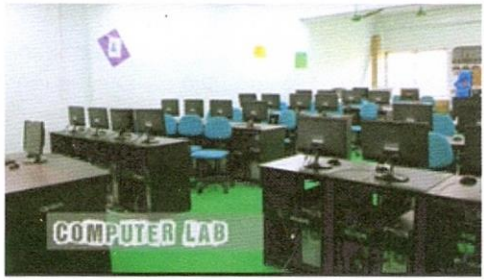
5.4 Basic-Experiment and High-tech Laboratories

The existing laboratories of CSE, EEE, ETE, Pharmacy have to be upgraded.

ETE Lab (IIUC)

Internet & Simulation Lab at IIUC

IIUC Computer Lab



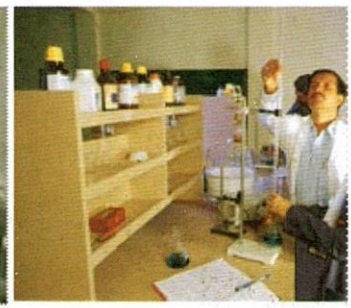
IIUC Electronics Lab

Particularly the 1st to 3rd semesters Labs should contain all the basic equipments for experiments in Physics, Chemistry and Electronics in addition to using computers (where necessary). In engineering labs each bench should have DC power supplies to 30V, Digital and Analogue Oscilloscopes, Digital & Analog Multimeters and Wattmeters and Function Generators; Soldering Irons also should necessarily be available for use.

The laboratory should be equipped with the latest tools for analog and digital electronics, and signal processing. The electronic laboratory serves the undergraduate students and enables students to conduct basic experiments of the relevant courses. Students should also be familiar with electronic measurement techniques and tools, such as the oscilloscope, power supply, digital multimeter, and function generator. Furthermore, the laboratory accompanies the graduation projects of undergraduate and graduate level students with Programmable Logical Controller (PLC) and other technical instruments. Further lab facilities should be upgraded in the case of Electrical Machine Lab. The computer facility of the existing VLSI lab should be enhanced. A complete electro-mechanical workshop should also be established. The existing Power protection lab should be equipped with required machineries & equipments. Research Lab for Renewable energy and Materials sciences are also to be established.

Typical EEE/ETE Laboratory

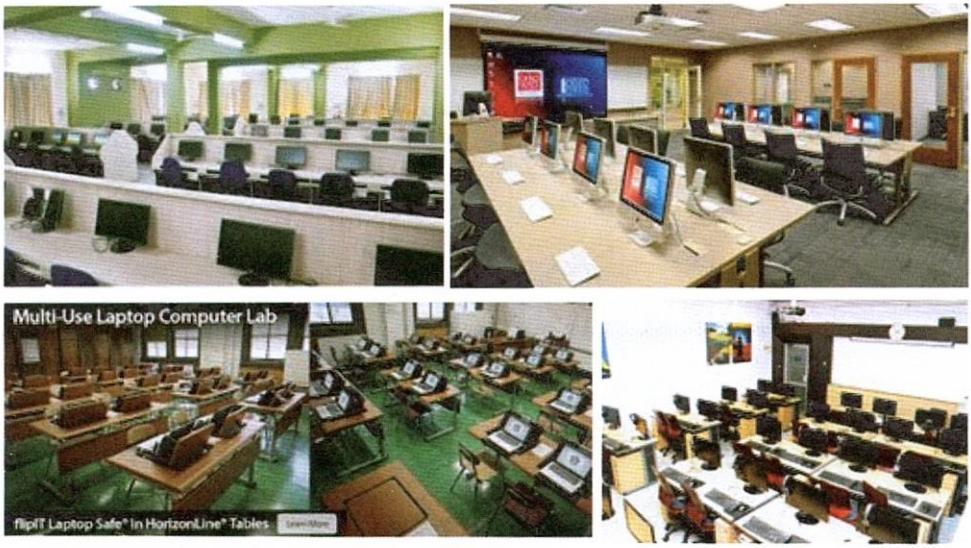
Chemistry/Pharmacy Lab



High-tech laboratories having equipments with state-of-the-art work stations with licensed software play an important as part of learning experience. Laboratories have to be fully equipped to meet the academic requirements as per the university curriculum.

To name a few; MATLAB and Simulation & Computational labs in Electrical Engineering, Microprocessor & Micro Controller Lab with software, Microelectronics Lab with Cadence software, VLSI with Cadence software, Embedded System Lab, different softwares in Electronics and Communication Engineering for carrying out different experiments.

Some proposed labs



The following special labs (some equipments are in the process for procurement) should facilitate graduate and research students of Electronics and Telecommunications Engineering (ETE). The same facilities would also supplement EEE/CSE requirements.

1. Photonics & Fiber Optics Laboratory: Information Technology and Telecommu nications; Health Care and the Life Sciences – Biophotonics; Optical Sensing; Lighting, and Energy; Education and Research.
2. Control, Vision and Robotics Laboratory: Computer vision for robotics and medical applications; Modeling, identification and control; Mechanical design and mechatronics; Interventional imaging and image-guided therapies; Education and Research.
3. Biomedical Signal Processing Laboratory: Developing advanced signal processing and estimation methods for analyzing and understanding biomedical signals; Advancing knowledge of path physiology through the investigation of behavior that manifests in physiologic signals; Providing opportunities for student participation in rigorous research methodology and the dissemination of knowledge; Contributing to regional and national biomedical research.

4. Advanced Mobile and Wireless Communications Laboratory: Developing advanced wireless communication 5G network; Advancing knowledge of signal processing on communication perspective; Research on statistical wireless communication system; Real world based problem solving for enhancing skill of future practicing engineers.

5.5 Library Facilities and Automation

The library services are the cornerstone of the education system. The mission of IIUC library services is to facilitate creation of new knowledge through acquisition, organization and dissemination of knowledge resources.

The libraries should have spacious reading halls, periodical centers, group discussion rooms and online database browsing areas.

The library is a learning space where students are inspired to explore, research and create. The library is not only the place to think, but also an informal work area where students gather to collaborate. IIUC library houses a collection of more than 80,576 books. Furthermore, the students have at present access to more than 13,691 electronic journals available online, apart from print journals and daily newspapers. The space (currently 33,850 sft) facilities have to be enhanced in the years to come.

IIUC has at the moment access to a good number of e-resources as listed below:

a. e-Resources

American Astronomical Society
American Physical Society
American Institute of Physics Journal
American Society of Agricultural and Biological Engineers
Annual Reviews
Brill's Developing Countries Journals Program
British Institute of Radiology Journals
Cambridge University Press
Canadian Science publishing (publisher of the NRC Research Press journals)
Cochrane Library (Web)
De Gruyter LIS Books
Duke University Press Journals
EBSCO CMMC
Edinburgh University Press
Geological Society-The Lyell Collection Complete
International Forestry Review
IMF e Library
Mary Ann Liebert Online
OSA - Optical Society of America
Policy Press
Project MUSE books

Royal College of Physicians
Royal Society - Royal Society Journals Online
Society for Industrial and Applied Mathematics Journals
SPIE Digital Library
Springer eJournal
University of Chicago Journals
Wiley Online Library Full
Indian Journal

UGC Digital Library (UDL):

Emerald
IEEE
JSTOR

e-Book:

Free e-Resources:

ARDI
Bangladesh Journals OnLine- BanglaJOL
Hinari
OARE

Automation of IIUC Library

Automation is a process of using the machineries for easy working and saving the human power and time. When we use machine for collection, processing, storage and retrieval of information and do other works of library with the help of machineries that called library automation.

The IIUC library should in future be automated with the following scopes:

- Acquisition System: Automates the acquisition process, ordering, receiving, claiming materials from suppliers and returns and cancellations of materials. Acquisition can be done online if system is linked to an external network.
- Cataloguing System: Creation, storage, retrieval and management of bibliographic records and indexes.
- Circulation System: Handles circulation activities such as lending, return, renewal and place on hold.

Automated library areas

The main activities of IIUC may be gradually shifted from manual to the use of library system on installing an Integrated Library System (example, Virtua system as used in USIM from 2005 or other reliable system). Such system will enhance the library process of acquiring, cataloging, retrieving as well as circulating materials. Users are more comfortable in retrieving materials when they only need to access the OPAC (Online Public Access Catalogue) via Internet at the IIUC address to be created.

b. Video conferencing facility

IIUC library should have a video conferencing facility. A **video-conference** (or Video Conference) is a live audio and video connection between people in separate locations for the purpose of communication or interaction. Video-conferencing allows people to communicate visually from anywhere in the world.

Uses of video-conferencing include:

- Lectures and tutorials - Giving and receiving lectures/presentations from remotely located sites from around the world
- Debates
- Presentations
- Remote assessment
- Remote interviews
- Conducting meetings between research groups and academics based at different universities
- Distance Learning

Virtual Classrooms: The system provides the ability to connect to remote sites and provide a learning environment through the Video medium. This is a very open collaborative type forum for lectures tutorials etc. With document cameras and multi display options the lecturer can be seen on one screen discussing a document being presented on a second screen.

Often, persons wishing to do a videoconference can simply use several existing applications such as **Skype, Skype for Business, What's App, Facebook, IMO, Viber, Google Hangouts or any future Apps** to conduct their conference. These applications can be displayed for a conference in any teaching facility room which has a projector and screen, by using the laptop connection cable provided. Audio can be hooked into the room's amplifier and speakers if these are installed. Note also that these applications rely on the bandwidth available (usually at the receiving end). Video-conferencing using proper video-conference equipment tends to have a far higher resilience and be less susceptible to failure.

Video conferencing rooms

5.6 Automation in Academic Affairs, Examination and Accounts Divisions

Good and efficient customer service is not just about smiles and handshakes. It is also not burying in office personnel in paperwork, errors, and headaches. It is about speed, access, convenience, flexibility and simplicity. IIUC has already some kind of automation in accounting, admission and examination systems.

Currently the Controller of Examination (CoE) office provides some services to the students through automated software. The Academic Affairs Division (ACAD) uses URMS software to facilitate some of their services. Development of online admission software for all works relating to distribution & receiving of admission form, admission and processing of admission test results etc. is required.

The academic office (database with student admission and other information) and Controller of Examinations office (database with all kinds of information regarding student's registration of courses, dropping of courses, Admit card for examination, result processing, issuance of Provisional & Final certificates etc) should all be automated fully in a fail-safe way. The current system of operations in the Accounts and Finance Division with limited automation should also be included in the plan for full automation in order to offer a user-friendly experience for students including online payment.

5.7 Developing Residential University (Home away from home)

Residential Accommodation for Student, Faculty & Guest: There are one teachers' dormitory and several halls of residence in the campus (plus two in Bohaddarhat) for students. Demands for more residential accommodation are in place. At least 3 teachers' and staffs' residential buildings (each of at least 10-storyed) and five more halls of residences for students are to be built in the campus.

Many students come from all across the country and overseas to live in IIUC residences, which come closest to being a home away from home. IIUC should create inclusive communities that foster student health and wellness, personal and social development, academic excellence and good citizenship. Breakfast and lunch are to be served in the university's dining-room. As a result each hall should be equipped with a kitchenette and service staff. Each hall also should have the benefit of Wi-Fi access.

One should be able to make home away from home and live alongside a lively, diverse group of other students at the University Residences. Separate facilities for boys and girls, caring Provosts/House Tutors and tight security arrangements should ensure a pleasant stay, allowing students to focus on academics.

Facilities including a Post-office, Internet access ensure close contact with family and friends outside. The common rooms should be equipped with TV, indoor games and other recreation facilities.

IIUC should promote creative connections and innovation both inside and outside of the classroom while providing a supportive, close-knit environment designed to set student up for success. When living on campus, students should be able to take advantage of the opportunities that are right outside the door. Arrangements should be in place for enjoying the convenience of all-inclusive living, while being steps away from academic buildings, student services and campus dining locations.

Overnight guests and visitors: Whether you are visiting IIUC campus as external expert member, conducting research or attending a conference, IIUC should make it its number one priority to provide the best possible accommodation services during such stay.

IIUC should commit to create a clean, well maintained, safe and secure environment for the comfort and protection of students, faculty, staff and guests. Each resident is expected to abide by the established rules and regulations of the university.

Off-campus accommodation: Arrangements for adequate number of off-campus accommodation particularly for staff members are to be made in the vicinity of the university.

5.8 STAD Activities – Sports & Games, Literary & other Competitions; Counseling and Career Guidance; Leadership Training Programs

IIUC launched this division (Student Affairs Division or STAD) to develop students physically, culturally, mentally and spiritually. STAD organize Sports and Recreation including tour to historical places and business organizations, pleasure trip/outing and study tour at home and abroad.

Sports & Games: Several sports and games are offered at IIUC. These sports and games are categorized as indoors and outdoors. Available indoor activities include table tennis, scrabble, chess and darts, just to mention a few. Outdoors sports include track or field athletics, football, basketball, volleyball and others.

The University should enhance the capabilities of the existing team responsible for coaching, managing and supervising and administering sport activities.

The University should arrange a wide variety of further sports facilities and equipment necessary for indoor and outdoor sporting activities. More pitches and courts (tennis, volley ball, cricket etc.) should be made available for games in addition to the existing ones. Further plan should include:

- A stadium with necessary facilities (including football, basket ball, cricket ground).
- A 20-meter swimming pool.
- Sports and recreation rooms in various students' halls of residence for indoor games and martial arts.

Stadium with Football, Cricket field inside

20-meter Swimming Pool

Literary & other Competitions: Annual Literary activities, competitions etc are to be continued as are being arranged at present.

Counseling and Career Guidance: STAD should provide (a) group and individual counseling, (b) career and job placement, (c) preserving CVs of the graduates, (d) advising & helping students to solve their career related problems etc.

Leadership Training Programs: Today's students need Leadership training like never before. Leadership training teaches important life skills, such as introspection, cultural sensitivity, moral acuity, people skills, debate and decision-making acumen. The future generations need to be equipped to make their own opportunities. They need the skills, knowledge, and qualities that leadership programs cultivate: self-reliance, creativity, and team-building skills, ethics, and more.

Currently IIUC Leadership Training involves First Aid (with the collaboration of Bangladesh Red Crescent Society & ICRC), Fire Service & Civil Defence. This type of leadership training and opportunities to IIUC students by STAD have to be broadened. STAD should organize Motivational Programs, more Public Speaking and Cultural activities, which would cover debate competition (Bangla & English), essay competition, cultural festival, public lecture series, workshop and recitation, presentation, standard pronunciation, news casting, debating etc.

Further activities of STAD should be to Organize Student Activities Unit, which covers mainly (a) seminars- symposia, (b) discussion meeting in observance of important national and Islamic days and occasions, (c) Orientation Program at the beginning of every semester, (d) formation of Leaders Council, (e) formation of clubs and societies like debating club, games and sports club, literary and cultural societies etc. (f) Departmental Club like Business Club, ETE Club, EEE Club, Law Club, Pharma Club, Language Club etc. See 'Constitution of Clubs/Societies' in Appendix II of "University Songbidhi" (approved by 197th Syndicate, 3rd Dec 2016)

All these would help to attain and develop outlooks and characteristics of students such as ethics and morality, mutual love and respect. The active participation in co-curricular & extra-curricular activities would also help to create critical, rational and strategic mind and for skill development, discipline and leadership.

5.9 Medical Facilities

A healthy body makes for a healthy mind. In order to ensure well-being of IIUC family, IIUC has a medical center with medical staffs and ambulances. In future it should arrange tie-ups with renowned hospitals in Chittagong to take care of any kind of emergency.

Student Health Center should be modernized for quality care in times of sickness and injury to promote and educate about personal health issues for IIUC students and staffs. It should include at least 10-bed inpatient unit. Students who require close observation or who need bed rest may receive care in the inpatient unit for a few hours, or a few days, depending on the patient's needs.

The medical staff may send students needing hospitalization to nearby hospitals. If hospitalized off campus, the student is responsible for payment of all medical services and charges of the medical care provider(s).

Beds inside medical center

Medications: Common over-the-counter and prescription medications should be made available at the Student Health Center. Over-the-counter medications are provided to students, at the direction of a medical professional, at minimal or no cost.

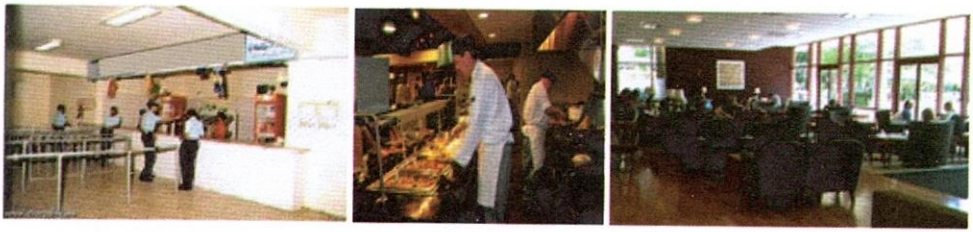
5.10 Central Cafeteria and University Dining Halls

What you eat is what you are!
A healthy mind can only reside in a healthy body. Hence, all dining halls and cafeterias should have menus that are healthy, nutritious and wholesome food to ensure a well-balanced diet. These may sometime need to be checked by professional dietician. The Central Cafeteria should thus offer all-you-can eat premiere offerings for everybody wanting to have breakfast, lunch and dinner. Fresh fruit juices, milkshakes, ice creams and other healthy snacks should be available in the cafeteria.

Food serving places in the cafeteria must be modernized as shown in pictures below.

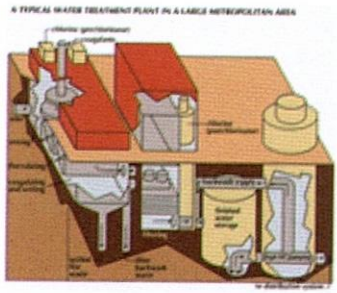
The University Dining Halls at different Halls of residences should provide healthy, nutritious and wholesome food to the students at affordable cost for breakfast, lunch and dinner.

Arrangement of food serving in a cafeteria



5.11 Drinking Water Purification Plant

Measures taken to ensure water quality not only relate to the treatment of the water, but to its conveyance and distribution after treatment. It is therefore common practice to keep residual disinfectants in the treated water to kill bacteriological contamination during distribution.



A Typical Water Treatment Plant

UC Water Treatment Plant

A newly built facility has been opened on 22 May 2017. The IIUC authority should arrange proper security of the plant as well as timely distribution to places where it is needed.

5.12 Banks and ATMs

Branches of Banks are to be opened in the campus. These should offer Automated Teller Machine (ATM) facilities and locker facilities, besides other regular bank services.

5.13 School and College

IIUC should establish school and college for the children (including grown up boys and girls) of IIUC faculty, community members, and administrators. The local community should also be allowed to send in their children. This would create an effective, reflective, and joyful learning community and would ultimately benefit IIUC.

5.14 Shopping Complex

A proper shopping center should be built with the following facilities:

- Saloon
- Laundry
- Grocery shop
- Book shops
- Tailors

5.15 Secure Campus Environment (including CCTV surveillance)

The security of the campus including the female zone should be well planned. At present there are 90 security guards under two security officers who are retired army personnel. They are under the guidance of "University Security Division".

In order to secure different buildings and installations, entry to the campus via rail gate must be well-regulated. The rail gate is one of the key points to be made risk-free. The rail crossing must be manned 24 hours by properly trained personnel. Proper lighting arrangements in all areas are to be maintained.

Keeping IIUC, IIUC students, staffs, IIUC properties safe and secure

CCTV Security for the campus is to be installed in key positions throughout the campus for proper surveillance. These are for keeping a close eye on the property of IIUC or

capture trespassers on video (cameras to be mounted in front of buildings, railway gate, parking lots in deterring criminal activity, and also inside buildings in sensitive points to catch computer thieves etc). Although having a CCTV camera in an area may not always prevent a crime from happening, it can be used to record the crime taking place. The purpose is to facilitate the detection of crime, identification, apprehension and prosecution of offenders in relation to crime and public order and for use in disciplinary investigations arising from alleged criminal activity or equivalent malpractice.



The railway gate is to be manned like at present but with specially trained security guards as students and hundreds of buses, small cars and other vehicles cross the gate almost 24 hours each day.



IIUC campus is big, so running cable from building to building is out of the question. Some buildings should have their own recorders, to reduce this burden. Monitor multiple locations with different security camera systems. One can use available software to automatically archive video stored on local DVR/NVRs onto central monitoring station where a surveillance manger and specialist can manage all the cameras, video, and archiving.

Security Patrol staff can also provide an effective front line service across the University by reassuring staff and students as well as being a visible deterrent to the local criminal elements by enforcing university environment.

Key Control: Building and room access door keys should be kept in a secure key cabinet, and are only issued out to authorized personnel.

5.16 Landscape and Campus Beautification

IIUC campus at Kumira includes over 43 acres of land with a sizable area full of different kinds of plants and trees, gardens, courtyards, spaces covered with grass, hill-side, woodland, athletic fields, small canal.

The campus is undergoing an ongoing transformation through a "Beautification Committee" to beautify the grounds and create a sustainable and environmentally friendly campus. The drainage and internal roads are to be properly constructed.



The ongoing development of the landscape and beautification should be geared to:

- create a beautiful environment for our students, staffs visitors and our community,
- do what's right for the environment — the more trees, gardens, the water quality, the air quality,
- improve the internal roads, arrange sitting place under shade, walkways,
- beautify campus landscape including canal areas with sitting places and water fountain.

Guidelines for Posters

- All postings must have an identifiable sponsor and contact number,
- Do not allow any postings on university walls, entrances, grounds. On discovery these should be removed immediately.
- All student postings, if allowed, should be put on any of the designated Bulletin boards only after stamped by STAD.
- Commercial ads in principle should not be allowed.

5.17 New Master Plan - Landscape Strategy, Internal Road & Transport System

A revised Master Plan of IIUC should aim at future development strategy with proper internal road and to create new landscaped areas in addition to new faculty and residential buildings.

The strategy is to create a clear road hierarchy, which promotes walking, sitting and cycling in the central core, allows for access to the Halls of Residence from within the campus. The improvement of the internal road network is fundamental to the strategy of gaining access to all parts of the campus from within and improving security.

A landscape strategy is being prepared for the campus, which will identify different landscape character zones. Matters such as co-ordinating street furniture will need to be addressed. During such strategy ensure that the architecture and landscape quality of the campus is not compromised by roads and parking facilities.

The campus should include an internal ring road which needs to be developed to help students/staffs travel between buildings on campus.

Transport: In order to keep the campus safe and noise free reduce unnecessary traffic movements by controlling movement of cars/buses across the campus.

The future development of the campus is dependent upon creating better transport linkages with the City of Chittagong and as well as internal traffic flow. The ability of the university to grow remains linked to the ability to bring students and staff to and from the campus. For this new arrangement is to be made with the railway authority to link Kumira station (as stoppage) with the city by special train.

5.18 Waste Management System

Most commonly used methods of waste disposal are Landfills, Incineration / Combustion and Recovery and Recycling.

Landfills: Throwing daily waste/garbage in the landfills is the most popularly used method of waste disposal used today. This process focuses attention on burying the waste in the land. Sometimes other process is included that eliminates the odors and dangers of waste before it is placed into the ground.

This method is associated with the strong presence of methane and other landfill gases, both of which can cause numerous contamination problems. Landfills give rise to air and water pollution water pollution which severely affects the environment and can prove fatal to the lives of humans and animals.

Incineration/Combustion: Incineration or combustion is a type disposal method in which solid wastes are burned at high temperatures so as to convert them into residue and gaseous products. The biggest advantage of this method is that it can reduce the volume of solid waste to 20-30% of the original volume.

This process is also known as thermal treatment where solid waste materials are converted by Incinerators into heat, gas, steam and ash.

Recovery and Recycling: Resource recovery is the process of taking useful discarded items for a specific next use. These discarded items are then processed to extract or recover materials and resources or convert them to energy in the form of usable heat, electricity or fuel.

Recycling is the process of converting waste products into new products to prevent energy usage and consumption of fresh raw materials. Recycling is the third component of Reduce, Reuse and Recycle waste hierarchy. The idea behind recycling is to reduce energy usage, reduce volume of landfills, reduce air and water pollution, reduce greenhouse gas emissions and preserve natural resources for future use.

Please see Appendix III-Waste Disposal

Chapter 6

Future IIUC Campus - Inspiring, Supportive and Sustainable

6.1 Inspiring, Supportive and Sustainable Campus

IIUC must aim to deliver the outcomes of the MUST-DO PLANS by each year making progress on the already stated IIUC's strategic objectives.

All endeavor should be focused to

- Build sufficient physical infrastructure which would be adequate and inspiring to everybody in the campus.
- Further continuously improve learning environment based on a personal engagement with all students, with high quality research-engaged teaching and learning where students create and develop new knowledge in collaboration with their lecturers.
- Promote a culture of enterprise and innovation across our communities (both locally and externally), working closely with employers.
- Develop and promote purposeful knowledge and research and develop innovative practices which produce new ideas that positively impact on an ever changing environment.
- Help students develop into highly engaged, employable and creative-thinking graduates who contribute to the development of society and the economy.
- Be entrepreneurial in our activities and practice across the whole institution and to develop new ways of working to facilitate a dynamic and innovative staff team.
- Create a strong financial environment to allow IIUC to invest in its future.

Appendix – I

World University Ranking

Types of Ranking

Ranking	Compiler/Publisher	Organization Type	Coverage Universities
Academic Ranking of World Universities (ARWU)	Shanghai Ranking Consultancy* 2009 - present http://www.shanghairanking.com	Commercial	1,200
Times Higher Education World University Ranking	Times Higher Education 2004-2009 jointly with QS https://www.timeshighereducation.com/world-university-rankings	Commercial/ Media	980 (2016-2017)
QS World University Ranking	Quacquarelli Symonds Ltd. 2004-2009 jointly with THE https://www.topuniversities.com/qs-world-university-rankings	Commercial	916
Webometrics Ranking of World Universities (also known as Ranking Web of Universities)	Cybermetrics Lab - a research group of the Spanish National Research Council (CSIC) http://www.webometrics.info	Spanish NRC in Madrid 2004 – present	26,340 Twice a year Jan, July

Note (Sources: Wiki & other sites):

QS World University Rankings is an annual publication of university rankings by Quacquarelli Symonds (QS). Previously known as THE-QS World University Rankings, the publisher had collaborated with Times Higher Education magazine (THE) to publish its international league tables from 2004 to 2009 before both started to announce their own versions. QS then chose to still use the pre-existing methodology while THE adopted a new one. The QS system now comprises the global overall and subject rankings, alongside five independent regional tables (Asia, Latin America, Emerging Europe and Central Asia, the Arab Region, and BRICS). It is the widely read international ranking, along with Academic Ranking of World Universities and Times Higher Education World University Rankings. However, allocating undue weight to subjective indicators and having highly fluctuating results are their major criticisms.

In 2016 more than 4,300 institutions were considered by QS and 916 overall ranked. Indicators used are:

1. Academic Reputation from Global Survey 40%; 2. Faculty Student Ratio 20%; 3. Citations per Faculty from Scopus 20%; 4. Employer Reputation from Global Survey 10%; 5. Proportion of International Students 5%; 6. Proportion of International Faculty 5%.

THE's ranking uses various other measures in addition to research quality. There are several criticisms for the methodology used; Visit:
https://en.wikipedia.org/wiki/Times_Higher_Education_World_University_Rankings

Academic Ranking of World Universities (ARWU) -- Selection of Universities

ARWU considers every university that has any Nobel Laureates, Fields Medalists, Highly Cited Researchers, or papers published in Nature or Science. In addition, universities with significant amount of papers indexed by Science Citation Index-Expanded (SCIE) and Social Science Citation

Index (SSCI) are also included. In total, more than 1200 universities are actually ranked and the best 500 are published on the web. * Publisher: Shanghai Jiao Tong University (2003–2008), Shanghai Ranking Consultancy (2009–present)

Webometrics Ranking of World Universities, also known as Ranking Web of Universities, is a ranking system for the world's universities based on a composite indicator that takes into account both the volume of the Web contents (number of web pages and files) and the visibility and impact of these web publications according to the number of external in links (site citations) they received. The ranking is published by the Cybermetrics Lab, a research group of the Spanish National Research Council (CSIC) located in Madrid. The ranking started in 2004 and is updated every January and July. Today it provides Web indicators for more than 26,000 universities worldwide.

Webometrics – Methodology

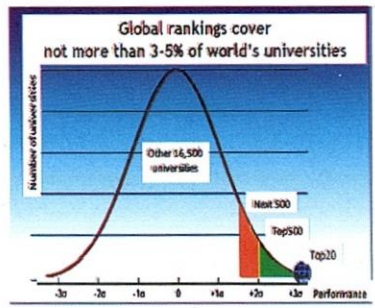
- **Visibility (50%)**
  - IMPACT - External inlinks that the University webdomain receives from third parties
  - The indicator is the product of square root of the number of backlinks and the number of domains originating those backlinks
- **Activity (50%)**
  - PRESENCE (1/3). The total number of webpages
  - OPENNESS (1/3). Number of rich files (pdf, doc, docx, ppt)
  - EXCELLENCE (1/3). The academic papers published in high impact interna tional journals

Webometrics Ranking: 2017 January (covers all the Universities Worldwide)

Country wise Comparison

Country	No. of Universities/HEI	World Ranking
Bangladesh	115	2025 - 26339
India	4004	511 - 26363
Pakistan	315	1567 - 26170
Malaysia	402	397 - 26363
Indonesia	486	817 - 26122
Thailand	180	443 - 26200
Sri Lanka	53	2171 - 25916
KSA	56	383 - 21864
S.Korea	375	77 - 26231
Singapore	44	57 - 24443
China	2310	257 - 26343
Japan	985	48 - 25620
Australia	199	81 - 24811
UK	285	8 - 24388
USA	3280	1 - 26336

Graph for top 3-5% world universities



Country Ranking - Bangladesh

Ranking	World Rank	University	Det.	Presence Rank*	Impact Rank*	Openness Rank*	Excellence Rank*
1	2025	Bangladesh University of Engineering and Technology	»	1179	5201	1591	1832
2	2283	University of Dhaka	»	2986	6325	1411	1952
3	2639	Brac University	»	741	4289	2094	3339
4	2776	University of Chittagong	»	9984	3477	3034	3068
5	2894	Rajshahi University	»	2854	8232	2164	2497
6	3172	Jahangirnagar University	»	12761	8488	2639	2307
7	3243	Bangladesh Agricultural University	»	5892	10591	2118	2401
8	3392	Shahjalal University of Science & Technology	»	2089	9381	2593	3125
9	3465	Independent University Bangladesh	»	2212	9106	2022	3414
10	3649	Khulna University of Engineering & Technology	»	2412	9646	3227	3339
11	3670	North South University Bangladesh	»	11926	8239	2228	3339
12	4146	Daffodil International University	»	1512	7362	4448	4482
13	4299	Khulna University	»	15351	10933	3625	3153
14	4433	American International University Bangladesh	»	9847	9317	3425	4032
15	4763	United International University	»	4765	12254	3453	3939
16	5100	Chittagong University of Engineering and Technology	»	14411	10995	4478	3860
17	5187	University of Development Alternative	»	21734	15901	4001	2444
18	5215	Islamic University Kushtia	»	22059	11731	3542	3506
19	5307	Rajshahi University of Engineering and Technology	»	17636	11152	5880	3566
20	5380	(4) Ahsanullah University of Science & Technology	»	14886	10841	5807	3860
21	5428	Jagannath University	»	12521	10926	3956	4330
22	5618	Bangabandhu Sheikh Mujib Medical University	»	6867	14046	4853	3860
23	5618	Bangabandhu Sheikh Mujibur Rahman Agricultural University	»	15224	12360	3791	4032
24	5738	International Islamic University Chittagong	»	12282	10608	3741	4673
25	5763	Sher-e-Bangla Agricultural University	»	15965	13884	5081	3459
26	5776	Islamic University of Technology	»	11625	8650	8635	3721
27	6072	East West University Bangladesh	»	3090	9685	2592	5778
28	6118	Dhaka University of Engineering & Technology	»	16130	12240	4780	4142

Ranking	World Rank	University	Det.	Presence Rank*	Impact Rank*	Openness Rank*	Excellence Rank*
29	6191	Southeast University	»	2626	13576	5966	4330
30	6238	National University of Bangladesh	»	2572	6900	8635	4916
31	6656	University of Asia Pacific Bangladesh	»	14942	11439	4838	4673
32	6727	Mawlana Bhasani Science & Technology University	»	21863	12890	4946	3939
33	6754	Chittagong Veterinary and Animal Sciences University	»	5479	15149	5409	4244
34	6754	Stamford University Bangladesh	»	16805	13652	4114	4244
35	6773	Patuakhali Science & Technology University	»	16114	12981	3731	4482
36	6907	Hajee Mohammad Danesh Science & Technology University Dinajpur	»	21063	12937	4706	4142
37	7014	International University of Business Agriculture and Technology University of Dhaka	»	19128	11561	4344	4673
38	8482	Noakhali University of Science & Technology	»	13481	13076	6164	4916
39	8696	Sylhet Agricultural University (Sher-e-Bangla Agricultural University)	»	17428	14611	3618	4916
40	9180	University of Liberal Arts Bangladesh	»	4078	12148	6431	5778
41	10148	Bangladesh University of Professionals	»	8907	9800	8258	5778
42	10203	Northern University Bangladesh	»	18276	12909	6233	5228
43	10376	Primeasia University	»	14350	15375	7310	4673
44	10384	Bangladesh Open University	»	14100	11467	6587	5778
45	10418	Asian University for Women	»	6234	15718	8147	4673
46	10786	Eastern University Bangla Desh	»	3025	13493	7511	5778
47	11077	ASA University Bangladesh	»	16531	10925	7443	5778
48	11168	Military Institute of Science & Technology	»	4636	15535	5581	5778
49	11314	(1) IBAIS University	»	13887	8975	8635	5778
50	11374	World University of Bangladesh	»	15683	13461	5445	5778
51	11536	University of Information Technology & Sciences	»	15853	16272	7563	4673
52	11890	Pabna University of Science & Technology	»	18613	13776	5125	5778
53	12138	Green University of Bangladesh	»	5070	14823	7484	5778
54	12644	Manarat International University	»	10922	13827	8635	5228
55	12874	Uttara University	»	12011	16346	5585	5778
56	13023	State University of Bangladesh	»	10756	14995	8514	5228

Ranking	World Rank	University	Det.	Presence Rank*	Impact Rank*	Openness Rank*	Excellence Rank*
57	13047	Jessore University of Science & Technology	»	18315	15309	5337	5778
58	13803	Jatiya Kabi Kazi Nazrul Islam University	»	19462	13536	7755	5778
59	13907	Premier University Chittagong	»	9075	17232	6870	5778
60	13935	Prime University	»	12011	16887	8635	4916
61	13954	Comilla University	»	17457	13315	8195	5778
62	14233	Presidency University	»	18945	15028	7293	5778
63	14393	Southern University Bangladesh	»	17449	14106	8147	5778
64	14414	BGMEA University of Fashion & Technology	»	16860	15718	7345	5778
65	14433	Metropolitan University Sylhet	»	18594	15375	7328	5778
66	15221	Bangladesh University of Textiles	»	18530	15281	8060	5778
67	15426	Begum Rokeya University Rangpur	»	20462	13187	8635	5778
68	15636	Bangabandhu Sheikh Mujibur Rahman Science and Technology University	»	20108	14525	8421	5778
69	15652	East Delta University	»	15898	16636	7970	5778
70	15858	Bangladesh University	»	20074	16636	7563	5778
71	16054	Sylhet International University	»	20300	16565	8635	5228
72	16266	City University	»	19659	14580	8635	5778
73	16380	Atish Dipankar University of Science & Technology	»	25156	15122	8635	5228
74	16390	Mymensingh Medical College	»	18674	18687	8635	4916
75	16682	Shanto-Mariam University of Creative Technology	»	14957	16199	8635	5778
76	17495	Armed Forces Medical College Dhaka	»	22207	15501	8635	5778
77	17585	Asian University of Bangladesh	»	22262	15605	8635	5778
78	17731	Bangladesh Islami University	»	20043	16395	8635	5778
79	17823	People's University of Bangladesh	»	19450	16679	8635	5778
80	17927	European University of Bangladesh	»	19409	18153	8258	5778
81	17969	Dhaka City College	»	19179	18758	8060	5778
82	18404	Bangladesh University of Business and Technology	»	14264	18687	8635	5778
83	18620	Royal University of Dhaka	»	21966	17122	8635	5778
84	18895	Bangladesh Medical College	»	23554	17010	8635	5778
85	19052	Victoria University of Bangladesh	»	25539	15644	8635	5778
86	19104	Port City International University	»	19651	18883	8514	5778
87	19193	Sylhet Mag Osmani Medical College	»	22910	17561	8635	5778
88	19271	University of Science & Technology Chittagong	»	25899	17042	7970	5778

Ranking	World Rank	University	Det.	Presence Rank*	Impact Rank*	Openness Rank*	Excellence Rank*
89	19524	Queens University	»	22262	18225	8635	5778
90	19551	The Millenium University	»	21955	18335	8635	5778
91	19641	Darul Ihsan University	»	24990	17232	8635	5778
92	19781	Khwaja Yunus Ali University	»	21367	20225	8195	5778
93	20128	(3) BRAC University Institute of Governance Studies	»	21220	19356	8635	5778
94	20508	North East Medical College	»	24954	18456	8635	5778
95	20573	Jahurul Islam Medical College	»	24614	18758	8635	5778
96	20701	Sylhet Engineering College Shahjalal University of Science & Technology	»	23097	19568	8635	5778
97	20746	International Culture University	»	17507	20909	8635	5778
98	20770	Dhaka International University	»	18587	20758	8635	5778
99	20901	South Asia University Bangla Desh	»	20121	20575	8635	5778
100	20976	Rangpur Medical College	»	23691	19716	8635	5778
101	21038	Central Women's University	»	22868	20069	8635	5778
102	21352	Dhaka National Medical College	»	23237	20400	8635	5778
103	21411	Hamdard University Bangladesh	»	20016	21256	8635	5778
104	21555	North East University Bangladesh	»	18494	21745	8635	5778
105	21938	Gono University	»	21631	21552	8635	5778
106	22112	Kumudini Women's Medical College	»	25381	22274	8635	5228
107	22552	BGC Trust University Bangladesh	»	24086	23426	8635	5228
108	22826	Pabna Textile Engineering College	»	24031	22055	8635	5778
109	23394	TMSS Medical College	»	20056	23678	8635	5778
110	23474	Ibrahim Medical College	»	17899	24055	8635	5778
111	23928	Pundro University of Science & Technology	»	24564	23426	8635	5778
112	24939	SZMC Shaheed Ziaur Rahman Medical College	»	17257	25407	8635	5778
113	25999	Centre for Medical Education	»	24238	26018	8635	5778
114	26255	(3) University of Dhaka Institute of Statistical Research and Training	»	6925	99999	8635	5778
115	26339	Chittagong Medical College	»	25981	26239	8635	5778

Appendix-II

Good Acoustic Lecture Room and Central Masjid

(Creating environments with listening conditions)

II.1 Introduction

IIUC must seize the opportunity to end a long-standing practice: the building of lecture rooms with inferior acoustics. This **invisible problem has far-reaching implications for learning, and problems in listening speech in IIUC Masjid**.

Excessive noise and reverberation interfere with speech intelligibility, resulting in reduced understanding and therefore reduced learning. In lecture rooms, particularly in the former Bahaddarhat campus, the speech intelligibility rating was perhaps around 75% or less. That means that, in speech intelligibility tests, listeners with normal hearing can understand only 75% of the words read from a list. Imagine reading a textbook with every fourth word missing, and being expected to understand the material and be tested on it. Sounds ridiculous? Well, that was exactly the situation facing students everyday at IIUC former campus.

The main reason for this acoustic problem is not lack of funds, but lack of awareness of the problem and its solutions. The best way to solve acoustics problems is to prevent them beforehand, not correct them after the fact. During the design process, acoustics problems can usually be avoided with a bit of forethought and a different arrangement of the same building materials. Renovation of poorly designed lecture rooms is much more expensive. Even then, the cost of renovation is small compared to the social costs of poor lecture room acoustics that impair the learning.

The need for good lecture room acoustics and the methods for attaining them have been known for decades, but this information has not been made readily available to architects, university planners, administrators, teachers, and parents. The sections are designed to provide a general overview of the problems and solutions concerning lecture room acoustics for both new construction and renovation (including central Masjid at Kumira).

Straightforward, practical explanations and examples are given; the Annexure provides quantitative definitions and calculations, as well as resources for more detailed information. The design of spaces with special acoustical requirements, such as auditorium, Masjid, or any spaces with complex noise problems, is best handled by a professional acoustical consultant. (Booklet© Acoustical Society of America)

II.2 The Basics

To understand how different spaces including lecture room should be designed that will yield "good acoustics", let us first familiarize ourselves with a few basic properties of sound. In general, sound radiates in waves in all directions from a point source until it encounters obstacles like walls or ceilings.

Two characteristics of these sound waves are of particular interest to us in architectural acoustics: intensity and frequency. Intensity is a physical measurement of a sound wave that relates to how loud a sound is perceived to be. We can also measure the frequency of a sound wave, which we perceive as pitch. For example, on a piano, the keys to the right have a higher pitch than those to the left. If a sound has just one frequency, it is called a pure tone, but most everyday sounds like speech, songs, and noise are complex sounds composed of a mix of different frequencies. The importance of frequency arises when a sound wave encounters a surface: the sound will react differently at different frequencies. The sensitivity of the human ear also varies with frequency, and we are more likely to be disturbed by medium-to high-frequency noises, especially pure tones.

Think of sound as a beam, like a ray of light, passing through space and encountering objects. When sound strikes a surface, a number of things can happen, including: Transmission-- The sound passes through the surface into the space beyond it, like light passing through a window. Absorption-- The surface absorbs the sound like a sponge absorbs water. Reflection-- The sound strikes the surface and changes direction like a ball bouncing off a wall. Diffusion-- The sound strikes the surface and is scattered in many directions, like pins being hit by a bowling ball. (See Figure 1) Keep in mind that several of these actions can occur simultaneously. For instance, a sound wave can, at the same time, be both reflected by and partially absorbed by a wall.

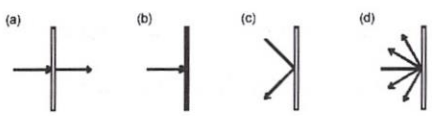


FIGURE 1. Sound/Surface Interaction: (a) transmission, (b) absorption, (c) reflection, (d) diffusion

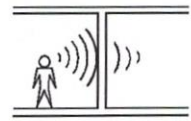


FIGURE 2. Noise Reduction between two spaces by a dividing wall.

As a result, the reflected wave will not be as loud as the initial wave. The frequency of the sound also makes a difference. Many surfaces absorb sounds with high frequencies and reflect sounds with low frequencies. The Absorption Coefficient (a) and NRC (noise reduction coefficient) are used to specify the ability of a material to absorb sound.

A special problem that results from reflected sound is that of discrete echoes. Most people are familiar with the phenomenon of shouting into a canyon and hearing one's voice answer a second later. Echoes can also happen in rooms, albeit more quickly. If a teacher's voice is continuously echoing off the back wall of a lecture room, each echo will interfere with the next word, making the lecture difficult to understand. Echoes are also a common problem in gymnasiums.

Another type of echo that interferes with hearing is flutter echo. When two flat, hard surfaces are parallel, a sound can rapidly bounce back and forth between them and create a ringing effect. This can happen between two walls, or a floor and ceiling.

Sound intensity levels and sound pressure levels can be measured in decibels (dB). In general, loud sounds have a greater dB value than soft sounds. Because the decibel scale is logarithmic rather than linear, decibels cannot be added in the usual way.

An important acoustical measurement called Reverberation Time (RT or RT(60)) is used to determine how quickly sound decays in a room. Reverberation time depends on the physical volume and surface materials of a room. Large spaces, such as cathedrals and gymnasiums, usually have longer reverberation times and sound "lively" or sometimes "boomy." Small rooms, such as bedrooms and recording studios, are usually less reverberant and sound "dry" or "dead."

The Noise Reduction (NR) of a wall (also expressed in dB) between two rooms is found by measuring what percentage of the sound produced in one room passes through the wall into the neighboring room. (See Figure 2) The NR is calculated by subtracting the noise level in dB in the receiving room from the noise level in the source room.

Signal-to-Noise Ratio (S/N) is a simple comparison that is useful for estimating how understandable speech is in a room. The sound level of the teacher's voice in dB, minus the background noise level in the room in dB, equals the S/N in dB. The larger the S/N, the greater the speech intelligibility. If the S/N is negative (i.e., the background noise is louder than the teacher's voice), the teacher will be hard to understand. Note also that the S/N varies throughout the room as the signal and noise levels vary. Typically, the S/N is lowest either: (1) at the back of the lecture room, where the level of the teacher's voice has fallen to its minimum value; or (2) near the noise source, where the noise level is at its maximum, such as near a wall air conditioning unit. Studies have shown that, in lecture rooms having a signal-to- noise ratio of less than +10 dB, speech intelligibility is significantly degraded for children with average hearing. Children with some hearing impairment need at least a +15 dB S/N ratio.

Speech intelligibility can be evaluated in existing rooms by using word lists. Several tests are performed wherein one person recites words from a standard list, and listeners write down what they hear. The percentage of words listeners correctly hear is a measure of the room's speech intelligibility.

For those interested in learning more about these topics, additional information is provided in the Annexure.

II.3 Acoustical Guidelines for Lecture Rooms and other spaces

The following guidelines are designed for a typical lecture room of ~ 30 students, where lecturing is done from the front of the room or students work in small groups. Recommendations for gymnasium, cafeteria, auditorium and Masjid are given in a latter section.

a. Reverberation

Though long reverberation time (RT) is the "common cold" of bad lecture room acoustics, there is a cure. Ideally, lecture rooms should have RTs in the range of 0.4 - 0.6 s, but many existing lecture rooms have RTs of one second or more. Figure 3 gives suitable reverberation times for various rooms typically found in educational facilities. The RT can be estimated fairly easily for both built and unbuilt lecture rooms with the use of the Sabine equation. The variables are the physical volume (cft) of the room, the areas (sft) of different surface materials, and the absorption coefficients of those materials at certain frequencies. (See formula and calculation in Annexure – Reverberation time). The absorption coefficient is a measure how much of the energy of a sound wave a material will absorb.

There are two ways to reduce the RT of a room: either the volume must be decreased or the sound absorption must be increased. Though decreasing the volume is not always an option, it is a viable alternative for many older lecture rooms with high ceilings. In such spaces, adding a suspended ceiling of sound-absorbing tile can significantly improve the Acoustics by simultaneously decreasing the volume and increasing absorption. However, adding a suspended ceiling often requires new light fixtures and can interfere with tall windows. The case study presented later shows an alternative solution for lecture rooms with high ceilings.

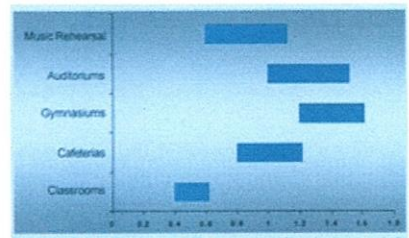


FIGURE 3. Suitable Reverberation Times (in seconds) for various rooms typically found in educational facilities.

Increasing the absorption in a room is accomplished by adding more "soft" materials, such as fabric-faced glass fiber wall panels, carpet, or acoustical ceiling tiles. Many products are commercially available for this purpose, and - with forethought - it is possible to design a lecture room with an acceptable RT using common building materials. Absorptive materials work best when spread throughout the room and not concentrated on just one wall or the floor or ceiling. In many lecture rooms, a suspended ceiling of acoustical ceiling tiles alone will decrease reverberation time to the desired range; however, this will not address the problem of echoes from the walls. Nor are all "acoustical" ceiling tiles created equal. Check the specifications and look for ceiling tiles with an NRC of 0.75 or better. In order to absorb both low- and high-frequency sounds, it is necessary to suspend the ceiling below the structural ceiling. **Simply adding carpeting to a lecture room floor will not significantly reduce reverberation time, especially at low frequencies, but carpeting will reduce noise resulting from students sliding their chairs or desks on the floor.**

For those interested in calculating the RT of an existing lecture room or estimating how much absorption is necessary, the Annexure includes examples and a table of absorption coefficients for some common materials.

b. Undesirable Reflections

As mentioned above, echoes interfere with speech intelligibility. Echoes can be controlled using absorption and/or diffusion. When locating absorptive materials to reduce reverberation time, consider how they might help reduce echoes as well. Placing an absorptive material on the rear wall of a lecture room prevents the teacher's voice from reflecting back to the front of the room.

While absorption is one way of minimizing reflected energy into the lecture room, another approach utilizes diffusion. Placing a diffusing element on the rear wall of the lecture room scatters the sound into many directions, so that the level in any one particular direction is greatly reduced. Flutter echo is a particularly significant problem when it occurs between the walls at the front of the room where the teacher is speaking. A simple way to test whether flutter echo is a problem is to stand near the center of the lecture room, between parallel surfaces, and clap hands once sharply. If flutter echo exists, a zinging or ringing sound will be heard after the clap as the sound rapidly bounces back and forth between two walls. Try turning in different directions and clapping again to determine which walls are causing the flutter echo. To eliminate flutter echo between two hard, parallel walls, cover one or both of them with fabric-faced glass fiber panels or a similar sound-absorbing material. This works well if the panels are staggered along the opposite walls so that a panel on one wall faces an untreated surface on the opposite wall. Splaying two walls at least eight degrees out of parallel will also eliminate flutter echo between them.

c. Useful Reflections

So far we have discussed methods for reducing reflections in lecture rooms, but in some cases we want to reinforce certain reflections. This is especially true in large lecture rooms that have short reverberation times. The sound energy of the teacher's voice can be absorbed by the soft ceiling before it reaches students at the back of the room. The teacher's voice can be spread throughout the room by shaping a sound-reflecting gypsum board ceiling over the front of the room, or by making the center of the ceiling a hard, reflecting surface. These surfaces will reflect sound toward the rear of the room. In order to maintain a low reverberation time with reflectors in the room, it will likely be necessary to add absorptive materials on the side and rear walls. The need for reflectors depends on the teaching methods used. For example, reflectors are useful in rooms used mostly for lecturing, but are not needed in rooms used only for small-group work or as laboratories.

d. Mechanical Equipment Noise

High ambient noise from mechanical equipment such as noisy heating, ventilation and air conditioning (HVAC) systems is all too common in existing institutions. This is a serious problem for teachers and students alike. Teachers must raise their voices to maintain the +10 dB signal-to-noise ratio necessary for good speech intelligibility.

Mechanical noise is primarily the result of poor planning and can be difficult and expensive to fix in existing lecture rooms. However, excessive mechanical noise can be eliminated at little or no extra cost if the system is designed properly in the first place. Mechanical engineers are sometimes unaware of or insensitive to this problem, and should be reminded that noise control is a critical issue that must be handled during the design and purchasing process.

There are many methods for measuring the loudness of mechanical noise. A good guideline is that the noise level in lecture rooms should not exceed NC 25 to 30. The NC, or Noise Criteria, rating is determined by measuring noise levels at certain frequencies, plotting these levels on a graph, then comparing the results to established NC curves. (A more detailed explanation is contained in the Annexure.) Another useful guideline is that the noise level should not exceed 35 dBA. This is an easily measured, single-number rating of the noise level over all frequencies that reduces the indicated noise level at lower frequencies to simulate the sensitivity of the ear. Typically, the noise level of a room in dBA is 5 to 7 dB higher than the NC rating. (Converting sound levels as measured in octave frequency bands to dBA is also explained in the Annexure).

Table (Figure 4). Common Mechanical Noise Problems

Problem	Identification	Solutions
The air in the ducts is travelling too fast, creating a whistle, rushing, or hissing sound as it passes dampers, turning vanes and diffusers.	Listen to the sound at different fan speeds to hear if it is reduced at slower air speeds. Open and close dampers, remove diffusers, and listen for changes in the noise.	Use slower fan speeds, increase the duct sizes, relocate dampers, and or use quieter diffusers.
Noise from the air handler (fan) is traveling through the ducts (supply or return) into the room.	Compare the noise in the room to the noise up close to the air handler. Listen to the characteristic whines or low rumbling.	Replace bare sheet metal duct with duct lined with sound-absorbing duct liner (keep in mind that this reduces the inside area of the duct and increases the air speed, so the lined duct need to be upsized). Reroute the ductwork to create a longer path from the air handler to the room. Insert a silencer near the air handler. Replace the air handler with a quieter model.
Nearby fan-coil units or variable air volume (VAV) boxes are generating noise which is transmitted into the room through the ductwork or the ceiling.	Turn unit on and off and listen for changes in noise.If possible, remove lay-in ceiling tiles and look/ listen for noisy units.	Move the unit away from the room (perhaps into an adjacent corridor in the case of a VAV box), eliminate it or replace it with a quieter model. Add lining or a silencer after the unit in the path of sound travel. Acoustically isolate the unit by surrounding it with a box built of gypsum board or some other dense material and interior acoustical liner to prevent sound from breaking out of the box through the ceiling and into the class room.

Figure 4 (in the form of Tableabove) lists a few common problems one can look for in an existing lecture room with excess mechanical noise resulting from a central mechanical system that distributes air to the rooms through ductwork.

To limit such noise, keep the following guidelines in mind when designing new lecture rooms:

1. Locate rooftop mechanical equipment, VAV boxes, and fan-coil units away from critical listening spaces such as lecture rooms. Positioning units over hallways and running ducts to nearby lecture rooms is one good solution. Avoid placing any major mechanical equipment inside, above, below, or adjacent to lecture rooms.

2. Select air handlers with low sound-level ratings.

3. Size ducts large enough to permit low air velocities. Select diffusers with NC ratings below 20 to 25.

4. Spend a little extra on longer duct runs. This pays dividends in reduced mechanical noise and crosstalk (the transmission of sound between rooms via ductwork). See Figure 5 for an example of good and bad duct arrangement.

5. Avoid using unit ventilators, fan coil units and ductless split systems in lecture rooms. These units contain fans and sometimes compressors that are notoriously loud and difficult to treat due to their position in the lecture room.

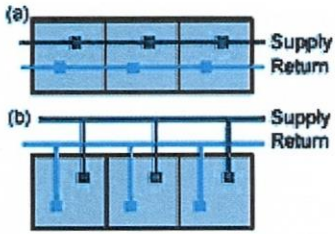


FIGURE 5. Duct Arrangements (a) bad duct arrangement - sound travels through the duct work from room to room, instead (b) good duct arangement - sound has a longer path to travel though lined duct between adjacent rooms.

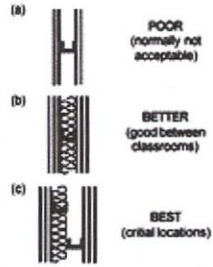


FIGURE 6. Gypsum Board Wall Constructions in order of least to most sound isolating (a) 1 layer gypsum wal board (GWB) each side (b) 2 layers GWB, glass fiber insulation, 2 layers GWB (c) 2 layers GWB, 2 sets of studs glass fiber insulation, 2 layers GWB

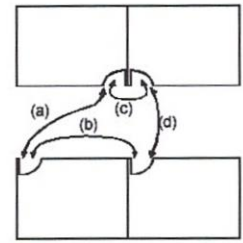


FIGURE 7. Door Layouts Paths (a) and (b) represent good layouts because the sound has a longer path to travel from one room to the next, paths (c) and (d) represent bad layouts because the distance between is short.

e. Interior Noise Sources

Noise from adjacent rooms disrupts the learning process, especially during quiet reading times or test-taking. Fifty years ago, when school walls were typically built of heavy brick or concrete block, this was not as much of a problem. In recent decades, the need to lower construction costs has led to the use of thin, lightweight wall materials that provide little noise reduction.

Figure 6 shows examples of both good and bad gypsum board wall construction. In general, as the mass of a wall is increased, its noise reduction also increases. However, a thick, solid wall is usually too expensive and heavy and wastes valuable floor space. Therefore, an effective compromise is to construct a wall of a layer of heavy material, an airspace, and another layer of heavy material.

Windows, doors, small gaps, cracks, grilles, louvers, etc. can completely negate a wall's effectiveness. Gaps between walls and the floor and ceiling should be sealed with an acoustical sealant. Thin or hollow-core doors with large gaps under them commonly cause sound leaks in otherwise good walls. Solid doors with tight-fitting, sealed frames are best. Their location also matters. For example, it is best not to pair up doors to adjacent rooms, as this provides a short path through which sound may travel from one room, through the doors, and into the next room. (Figure 7 shows both good and bad layouts.) Also, lecture room doors should not be placed directly across a hall from one another. Staggering doors across a hallway creates a longer, less direct path for noise to travel from one room to another.

To be effective, partition walls should extend from the structural floor to the structural ceiling. Otherwise, sound from one room can easily pass through a lay-in acoustical tile ceiling, over the partition wall, and down through the lay-in ceiling of the next room. (See Figure 8) This is commonly overlooked when walls are added during renovations, such as when open-plan lecture rooms are partitioned.

Preventive design can often eliminate the need for thick, expensive walls. During the design process, consider which rooms will be noisy (mechanical rooms, gymnasiums, cafeterias, music rooms, industrial design shops, etc.) and use buffer areas (hallways, storage rooms, and restrooms) to separate these spaces from critical listening areas (lecture rooms, libraries, special education areas, and offices).

f. Exterior Noise Sources

The noise reduction of exterior walls is also important since many noisy and potentially disruptive activities go on outside the school. Most schools are built with brick or concrete block exterior walls, which are good sound barriers, but with inadequate windows that permit considerable sound transmission. To provide noise reduction, windows must be well sealed. Double-paned glass provides better noise reduction than single-paned glass (as well as better thermal insulation and decreased energy costs). Other common sound leakage culprits are wall-mounted unit ventilators that duct directly outside. These units not only transmit exterior noise but generate ample noise themselves; they should be avoided whenever possible.

During site planning, consider external noise sources that could disrupt learning and attempt to locate lecture rooms away from such areas. Common noise sources include: aircraft flyovers, busy roads, idling school buses, playgrounds, playing fields, exterior mechanical equipment, dumpsters being emptied by garbage trucks, lawn mowers, and noisy machinery in nearby buildings.

g. Sound Reinforcement

Sound reinforcement systems, often referred to as "soundfield" or "soundfield FM" systems, are sometimes suggested as relatively inexpensive solutions for lecture rooms with poor signal-to-noise ratios.

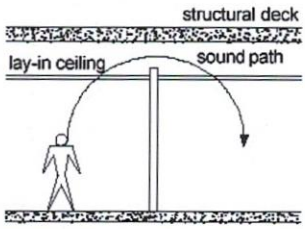


FIGURE 8. Sound Travels over the partition wall, through lay-in ceiling. Partitions must continue all the way to structural deck to be effective sound barriers.

FIGURE 9. Open Plan Classrooms While advantageous for certain teaching methods or student interaction, they have serious drawbacks acoustically. Although partial-height partitions or operable partitions eliminate visual distractions, they provide very little noise reduction between classrooms.

A typical system consists of a wireless microphone worn by the teacher and one or more loudspeakers located at the front of the room, in the ceiling, or along the walls to distribute the sound to the students. Amplifying the teacher's voice raises the signal-to-noise ratio, which improves speech intelligibility and reduces vocal strain. This can be useful in a room with a moderate amount of mechanical noise that would otherwise be difficult or expensive to silence. However, such systems also have their limitations. An overly-reverberant lecture room, for example, will cause the sound from the loudspeakers to build up and remain unintelligible. Whether or not a sound reinforcement system is used in the lecture room, it is vital to employ acoustical treatments that reduce reverberation time.

Another drawback to sound reinforcement systems is that they amplify only the teacher. Students are not amplified when they ask the teacher questions or talk among themselves while working in groups. Some systems provide an extra handheld microphone that students can pass around. However, this is a cumbersome solution that interferes with spontaneous discussions. Also, if the microphone is not kept close to the person speaking, it will pick up as much ambient noise as speech, and the S/N will not be improved. Still another problem is that the amplified sound will become noise for adjacent lecture rooms. Despite these shortcomings, sound reinforcement systems can be cost-effective improvements for lecture rooms with high noise levels, and are usually better than no modifications at all.

h. Examples of Good and Bad Lecture Rooms

How do all of these pieces of the puzzle fit together? This section provides examples of good and bad lecture room acoustics to illustrate how architectural finishes can be used to control reverberation and echoes.

From an acoustical standpoint, open-plan lecture rooms are perhaps the worst. While they can be advantageous for certain teaching methods or student interaction, they have serious acoustical drawbacks. Students are easily distracted by acoustical and visual signals that spill over from adjacent classes. And if students with hearing impairment or attention deficit disorders have difficulty concentrating on the teacher's voice in a lecture room with loud mechanical noise, consider their plight in a lecture room where the background noise is not random but rather an intelligible signal. To combat these problems, many open-plan lecture rooms have been divided with partial-height partitions or operable partitions that slide out like curtains. While these barriers do help students focus by eliminating visual distractions, they provide little noise reduction between lecture rooms. (Figure 9 shows an example of an open plan.)

Another undesirable design is the lecture room with a tall plaster or gypsum board (hard) ceiling, hard walls and hard tile floor. In such a lecture room, echoes and reverberation tend to destroy speech intelligibility, especially for young children. Unlike mechanical noise, reverberation cannot be overcome by raising the level of the teacher's voice. An acoustical treatment must be added to increase absorption and reduce harmful echoes. (See Figure 10a) For suggestions on materials, refer to the section in the Annexure on reverberation time. For a nontraditional solution, read the case study below.

Simply including a sound-absorbing lay-in ceiling and thin carpet on the floor will usually result in good lecture room acoustics and low reverberation time. This solution is inexpensive for new construction and is also an affordable way to renovate existing lecture rooms. For small to moderate-sized lecture rooms, the lay-in ceiling will provide an acceptable reverberation time, provided that acoustical ceiling tiles with an NRC greater than 0.75 are used. The carpet adds some high-frequency absorption, but primarily serves to reduce self-noise from the students. (Refer to Figure 10b) Unfortunately, this approach does nothing to control echoes from the walls. However, thoughtful arrangement of furniture such as cabinets and bookcases can help break up large, flat walls and reduce echoes.

The best design for a lecture-style lecture room would be to move some of the absorption from the ceiling to the walls and keep the middle of the ceiling hard to reflect the teacher's voice toward the back of the room. This seemingly complex, partially absorptive and partially reflective ceiling can be easily built with a standard ceiling grid. Simply place acoustical ceiling tiles around the perimeter of the ceiling and gypsum board panels in the center of the grid. To reflect more sound to the back of the room, the ceiling can be shaped over the teacher's location at the front of the room. This reflecting surface should be built from a hard material like plywood or gypsum board, and can be painted to match the room. Placing absorptive materials on the walls simultaneously reduces reverberation time and kills echoes. Fabric-covered, 2 inch thick glass fiber panels are a good choice because they are attractive, fairly rugged, and provide some absorption at low frequencies. Add thin carpeting to the floors, and the result can be an acoustically wonderful lecture room, with a low reverberation time, no echoes, proper distribution of reflections, and low self-noise, all achieved with common building materials. (See Figure 10c)

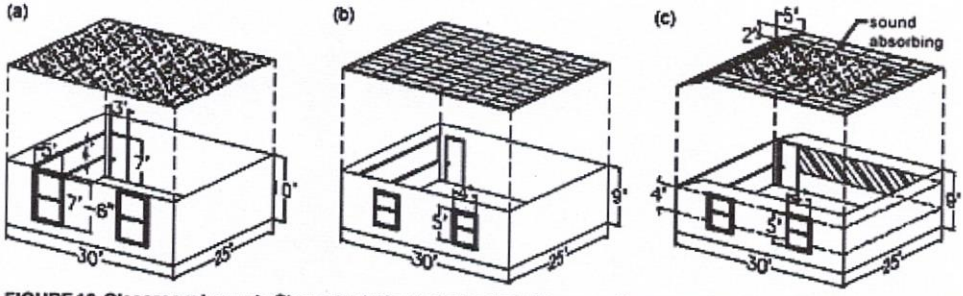
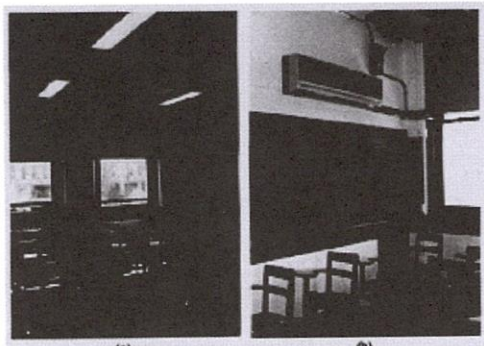


FIGURE 10. Classroom Layouts Classroom (a) is a typical undesirable room with no sound absorbing material and no useful reflection patterns. Classroom (b) is better with an acoustical lay-in, sound absorbing ceiling and thin carpeting. Classroom (c) is a desirable room with sound absorbing wall treatment on three walls, thin carpet, a sloped ceiling reflector at the front, and a ceiling with reflecting surfaces in the center and sound absorbing surfaces around the perimeter.

i. Case Study – Older Lecture Rooms

The topic of this case study is a lecture room in an older university building that was the subject of complaints from teachers about the generally poor acoustical conditions including high noise levels and poor speech intelligibility. While this is a university lecture room, its design is typical of many lecture rooms in older elementary and secondary schools. The room, shown in Figure 11, has high plaster ceilings and many tall windows. The building was originally constructed with no central air conditioning system, so several window air conditioners were added, which were very noisy. In order to properly prepare recommendations for improving the acoustical conditions of this room, the ambient noise levels as established by the window air conditioning units were measured and the reverberation times of the room were also measured. It was important that acoustical conditions be improved without adversely affecting room aesthetics.



(a) (b)

FIGURE 11. Older Classroom Improvements Photograph (a) shows the added sound absorptive material in the form of hanging fabric faced glass fiber panels, wall mounted fabric faced glass fiber panels and carpeting. Photograph (b) shows the relatively noisy wall mounted air conditioning unit with two fan speeds.

Due to the high ceiling and lack of absorptive materials in the room, reverberation time was an unsatisfactorily long 1.5 seconds at middle frequencies. Adding a suspended ceiling of acoustical ceiling tiles would have improved the space acoustically but not visually. To avoid interfering with the tall windows, the suspended ceiling would have to be sloped up at the sides, and a new lay-in ceiling would not have matched the traditional architecture of the lecture room. Instead, 2 inch thick, dense glass fiber panels, covered with fabric that complemented the color scheme in the room, were suspended from the ceiling at the same level as the existing pendant-mounted lighting fixtures. This resulted is an aesthetically pleasing solution without the expense of replacing the lighting fixtures, which would normally be necessary when adding a suspended ceiling. Fabric faced glass fiber panels were also mounted on the walls between the windows to prevent echoes and further decrease reverberation time. After modification, the unoccupied reverberation time was reduced to a desirable 0.5 seconds in the middle frequencies. Similar solutions could be applied to many lecture rooms where suspended acoustical tile ceilings are not suitable.

The air conditioning system for this room was also modified with mixed acoustical results. The original window air conditioners created an unacceptably high noise level described by NC-57. The school decided to replace the window units with a wall mounted, two speed fan/coil unit and with the compressor properly located outside. This improved room cooling but it did not completely solve the noise problem. With the fan at high speed, the noise in nearby seating areas is NC-47, 10 points lower than the original NC-57, but still not suitable. On the opposite side of the room the noise is NC-43. with the fan at low speed the noise is NC-36 and NC-33. With low speed operation the noise is relatively close to the criteria (see page 4). But, at high speed the noise is significantly above the criteria. When in-room fan/coil units must be used for economic or physical reasons, multi-speed units should be employed, and the units should be capable of handling the cooling task with low speed fan operation.

j. Acoustical Guidelines for special Rooms e.g. Prayer hall (Masjid)

This section addresses acoustical issues for other common rooms. While these guidelines are not as comprehensive as the material on lecture rooms, much of the material presented earlier, such as the need to eliminate mechanical noise and provide effective noise reduction, also applies to rooms such as cafeterias, prayer halls, gymnasiums, and auditoriums. Special purpose rooms are complex and best handled by a professional acoustical consultant.

The most common problem plaguing cafeterias, prayer halls, gymnasiums etc is excessive reverberation time (RT), since they typically have both large physical volume and hard surface materials. In cafeterias, this long RT causes noise buildup, with students having to speak louder and louder to hear each other until there is a continuous roar.

Several options are available for improving sound absorption in these large spaces. In new construction, if the ceiling is constructed as an exposed metal deck, consider using metal deck with perforations on the bottom and glass fiber above to absorb sound. This will significantly reduce reverberation time without adding unduly to construction costs. Another option for either new construction or renovation is to hang absorptive baffles or banners from the ceiling. Baffles and banners are commercially available products made of several inches of glass fiber covered with thin plastic or cloth. They are easily installed, available in a rainbow of colors, and do not detract from the appearance of the room. Placing glass fiber or wood fiber panels on the walls will also reduce both RT and echoes.

University auditoriums accommodate a variety of activities, including speech, theater, and songs. All these activities require good acoustics, but each has different acoustical requirements. To meet the needs of all these activities, an auditorium's acoustics must either be compromised so it performs adequately for all functions, but favorably for none, or else a technique called "variable acoustics" must be used to adapt its acoustics to suit each function. Variable acoustics involves the use of panels, drapery, and other materials that can be easily rearranged to alter reflections, reverberation time, and other acoustical properties. To achieve satisfactory results for these complex rooms, it is best to seek the assistance of a professional acoustical consultant. That said, the following paragraphs provide a few design guidelines to follow and common pitfalls to avoid.

Combining the auditorium/Masjid with the cafeteria or gymnasium is a tempting way to save both money and square footage. Unfortunately, this rarely, if ever, results in an acoustically satisfactory auditorium since the rooms have conflicting requirements. In an auditorium/Masjid, the objective is to reinforce sound from a single location, while in cafeterias and gymnasiums the goal is to suppress noise from many sources. This conflict cannot be resolved effectively, so these room combinations should be avoided. In an auditorium/Masjid, the shape of the room is important to properly reflect sound into the audience. Avoid wide, fan-shaped halls with concave rear walls having a radius centered on the stage. A concave rear wall will focus disturbing echoes back to the performers on stage, and if the side walls are splayed too wide, they will not provide useful early reflections into the seating. To allow reflected sound to reach those seated in the back, under balcony depth should be less than twice the distance to the floor below. A flat ceiling will send all reflections to the back of the hall, so sections of the ceiling should be angled to spread reflections throughout the audience. Convex diffusing panels shaped like pyramids or cylinders or special "QRD" diffusers help scatter sound throughout the auditorium and reduce discrete echoes. Walls can be covered with heavy drapery that slides horizontally or rises vertically to add absorption when necessary and remove it when unnecessary.

Annexure to the above article

Frequency

Frequency is an important factor in most acoustical measurements. Sound occurs when a vibrating source causes small fluctuations in the air, and frequency is the rate of repetition of these vibrations. Frequency is measured in hertz (Hz), where 1 Hz = 1 cycle per second. A young person

with normal hearing can detect a wide range of frequencies from about 20 to 20,000 Hz. In order to deal with such a large spectrum, acousticians commonly divide the frequency range into sections called octave bands. Each octave band is identified by its center frequency. For the standard octave bands these center frequencies are: 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz. As you can see, the ratio of successive frequencies is 2:1, just like an octave in music. This also correlates with the sensitivity of the ear to frequency, since a change in frequency is more readily distinguished at lower frequencies than at higher ones. For example, the shift from 100 to 105 Hz is more noticeable than the shift from 8000 to 8005 Hz. Higher-frequency octave bands contain a wider range of frequencies than lower-frequency octave bands, but we perceive them as approximately equal. To obtain a more detailed indicator of the spectrum of sound power, measurements are often made in the one-third octave frequency bands. Standard center frequencies for the one-third octave bands are: 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000 Hz, etc. Note that an octave band contains the one-third octave band at the standard octave band center frequency plus the one-third octave bands on each side.

Decibels

The most common measure of a sound's level is Sound Pressure Level, or SPL, expressed in decibels, abbreviated dB. Decibels are not typical units like inches or pounds in that they do not linearly relate to a specific quantity. Instead, decibels are based on the logarithmic ratio of the sound power or intensity to a reference power or intensity. Sound power and intensity are not easy to measure. However, sound pressure is easily measured with a sound level meter. Sound pressure may also be expressed in dB since sound pressure squared is proportional to sound power or intensity. We use dB instead of the actual amplitude of the sound in units of pressure because its logarithmic value represents the way our ears interpret sound and because the numbers are more manageable for our calculations. Most sounds fall in the range of 0 to140 dB, which is equivalent to waves with pressures of 20 to 200,000,000 micropascals (or 2 x 10-10 to 2 x 10-2 atm). To help you get a feeling for sound pressure levels (in dB), the approximate SPLs of some common sound sources are given in Figure 12.

Source	SPL(dBA)
Faintest audible sound	0
Whisper	20
Quiet residence	30
Soft stereo in residence	40
Speech range	50-70
Cafeteria	80
Pneumatic jackhammer	90
Loud crowd noise	100
Accelerating motorcycle	100
Rock concert	120
Jet engine (75 feet away)	140

FIGURE 12. Sound Pressure Levels of common sound sources.

Description	Sound Reduction (av 100–3150 Hz)
Any type of window when open	about 10 dB
Ordinary single openable window closed but not weather-stripped, any glass	up to 20 dB
Single fixed or openable weather-stripped window, with 6 mm glass	up to 25 dB
Fixed single window with 12 mm glass	up to 30 dB
Fixed single window with 24 mm glass	up to 35 dB
Double window, openable but weather-stripped, 150–200 mm airspace, any glass	up to 40 dB
Double window in separate frames, one frame fixed, 300–400 mm airspace, 6–10 mm glass, sound-absorbent reveals	up to 45 dB

	Octave Band Center Frequency (Hz)								
	31	63	125	250	500	1000	2000	4000	8000
A-weighting	-40	-26	-16	-9	-3	0	+1	+1	-1
C-weighting	-2	0	0	0	0	0	0	0	-3

FIGURE 13. Frequency Discrimination in dB for A and C weighting.

A simple sound level meter combines sound pressure levels over all frequencies to give the overall SPL in dB. More complex meters have filters that can measure the SPL in each octave band or one-third octave band separately so we can identify the level in each band, thus identifying the spectrum of the sound. Sound level meters can also "weight" the sound pressure level by adjusting the level in different frequencies before combining the levels into a weighted overall level. For example, A-weighting reduces the level of sounds at low frequencies to simulate the variations in sensitivity of the ear to different frequencies. A-weighted values are denoted as dBA to differentiate them from unweighted dB levels. Similarly, C-weighted values are labeled dBC. C-weighting slightly reduces the level of sounds below 50 and above 5000 Hz, but is nearly flat in between, and can be used to approximate an unweighted reading on sound level meters that only offer A- or C-weighting. Comparing A- and C-weighted levels for a noise source can provide a rough estimate of its frequency distribution. If the two levels are within 1 or 2 dB, most of the noise is above 500 Hz. If the two levels vary by more than a few dB, a significant amount of the noise is in the lower frequencies. To convert unweighted octave band sound pressure levels into weighted A or C levels, add or subtract the amounts noted in Figure 13 from the corresponding frequency bands. Next, sum the octave band levels (two at a time as explained below) to arrive at the overall dBA or dBC value.

As mentioned earlier in the text, calculating the SPL of two sources together is not as simple as adding their individual decibel levels. Two people speaking at 70 dBA each are not as loud as a jet engine at 140 dBA. To combine two decibel values, they must be converted back to pressure squared, summed, and converted back to decibels. The mathematics may be approximated by using Figure 14.

Material	Frequency (Hz) 125	250	500	1000	2000	4000
Concrete/brick	0.01	0.01	0.02	0.02	0.02	0.03
Glass	0.19	0.08	0.06	0.04	0.03	0.02
Plasterboard	0.20	0.15	0.10	0.08	0.04	0.02
Plywood	0.45	0.25	0.13	0.11	0.10	0.09
Carpet	0.10	0.20	0.30	0.35	0.50	0.60
Curtains	0.05	0.12	0.25	0.35	0.40	0.45
Acoustical board	0.25	0.45	0.80	0.90	0.90	0.90

Difference between two decibel values	Amount added to higher value
0 or 1	3
2 or 3	2
4 to 9	1
10 or more	0

FIGURE 14. Decibel "Addition"

	Sound Absorption Coefficient (α) 125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
Glass Fiber Ceiling Tile	0.70	0.85	0.75	0.85	0.90	0.90
Fiberglass Wall Panel - 2 inch thick	0.30	0.50	0.80	0.90	0.80	0.75
Concrete Block, painted	0.10	0.05	0.06	0.07	0.09	0.08
Gypsum Wall Board	0.25	0.15	0.08	0.06	0.04	0.04
Plaster Wall or Ceiling	0.14	0.10	0.06	0.05	0.04	0.03
Linoleum or Tile Floor	0.02	0.03	0.03	0.03	0.03	0.02
Thin Carpet, on concrete	0.05	0.10	0.25	0.30	0.35	0.40
Wood Door	0.15	0.11	0.09	0.07	0.06	0.06
Glass	0.35	0.25	0.18	0.12	0.07	0.04
Chalkboard	0.01	0.01	0.01	0.01	0.02	0.02

FIGURE 15. Typical Absorption Coefficients for building materials commonly used in educational facilities

If one sound is much louder than the other, the louder sound drowns out the softer sound, and the combined decibel level is just the level of the louder sound. If the two sounds are equally loud, then the combined level is 3 dB higher. More than two sources can be combined, but they must be considered two at a time. For example, an unbuilt lecture room is expected to have 34 dBA of mechanical system noise, a computer that generates 32 dBA of noise, and an overhead projector that generates 43 dBA. What will be the total sound pressure level from the three noise sources? The difference between the first two decibel values is: 34-32=2, so add 2 dB to the higher value: 34+2=36 dBA. Then combine this with the projector noise: 43-36=7, so add 1 dB to the higher value: 43+1= 44 dBA total from the three noise sources. If the SPL of the teacher's voice is 55 dBA, what is the signal-to- noise ratio in the room? 55-44= +11 dB, which is sufficient for good speech intelligibility. How much louder is the total 44 dBA than each of the individual noise sources? Due to the response of our ears, we can just notice a difference of 3 dB. An increase of 10 dB sounds approximately twice as loud, and an increase of 20 dB sounds about four times as loud.

Reverberation Time

Over 100 years ago, a Harvard physics professor named Wallace Clement Sabine developed the first equation for reverberation time, which has since been named after him and is still used today. Reverberation time is defined as the length of time required for sound to decay 60 dB from its initial level. Sabine's simple formula is:

$$RT(60) = 0.05\ V/\Sigma\ a.S$$

where: RT(60) = reverberation time (sec), V = room volume (ft3), S = surface area (ft 2), a = absorption coefficient of material(s) at given frequency

To use this formula, the volume of the room, surface area of each material in the room, and absorption coefficients for those materials must be known. Absorption coefficients are measured in specialized laboratories, and represent the fraction of sound energy (not sound level-dB) the material will absorb as a decimal from 0 to 1. Figure 15 gives absorption coefficients for common lecture room materials.

A commonly used one-number rating called **NRC, Noise Reduction Coefficient**, is simply the average of the absorption coefficients at 250, 500, 1000, and 2000 Hz. This simple, one-number rating can be useful for comparing the relative absorption of two materials; however, examining absorption coefficients in each octave band gives a better idea of the performance of a material at various frequencies.

Reverberation time is often calculated with the room unoccupied. Since people and their clothing provide additional sound absorption, an unoccupied room is the worst-case scenario, though not an unreasonable one, since occupancy of most lecture rooms varies. In a complete analysis, this calculation should be performed for each octave band, as the RT can vary widely at different frequencies. However, for a quick estimate, the RT of a lecture room can be calculated for just one octave band representative of speech frequencies, such as 1000 Hz. If this RT is acceptable, then the RT throughout the speech range will likely be acceptable.

To demonstrate the use of the Sabine equation, Figure 16 provides an example calculation of the RT at 500 Hz for the acoustically poor lecture room example given in Figure 10a. Try calculating the RT at 500 Hz of the acoustically satisfactory lecture room in Figure 10b with only a sound-absorbing ceiling added. Note that the ceiling is lower in that example, so the volume and surface areas will change. The RT of the satisfactory lecture room is approximately 0.4 seconds.

$$V = (30\ ft)(25\ ft)(10\ ft)$$
$$= 7500\ ft^3$$

$$S? = (750)(0.03) + (75)(0.18) + (21)(0.09) + (100)(0.01) + (1654)(0.06)$$
$$= 138$$

$$RT(60) = \frac{(0.05)(7500)}{(138)}$$
$$= 2.7 \text{ sec at } 500 \text{ Hz}$$

FIGURE 16. RT Calculation example.

Absorption of Reflected Sound at Various Frequencies

Material	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
Brick	3%	3%	3%	4%	5%	7%
Carpet *(on concrete w/foam rubber pad)*	8%	24%	57%	69%	71%	73%
Drapes *(heavy velour)*	14%	35%	55%	72%	70%	65%
Drywall *(½" on 2x4s)*	29%	10%	5%	4%	7%	9%
Linoleum *(on concrete)*	2%	3%	3%	3%	3%	2%
Paneling *(⅜" on 2x4s)*	28%	22%	17%	9%	10%	11%
Plaster *(rough finish, over lath)*	14%	10%	6%	5%	4%	9%
Window Glass	35%	25%	18%	12%	7%	4%
Wood	15%	11%	10%	7%	7%	4%

	Octave Band Center Frequency (Hz)								
	63	125	250	500	1000	2000	4000	8000	NC
Window air conditioners	62	57	63	60	55	50	50	40	57
Fan coil Unit		46	47	54	48	41	30	23	50
Background noise	51	42	32	24	25	16	10	6	23

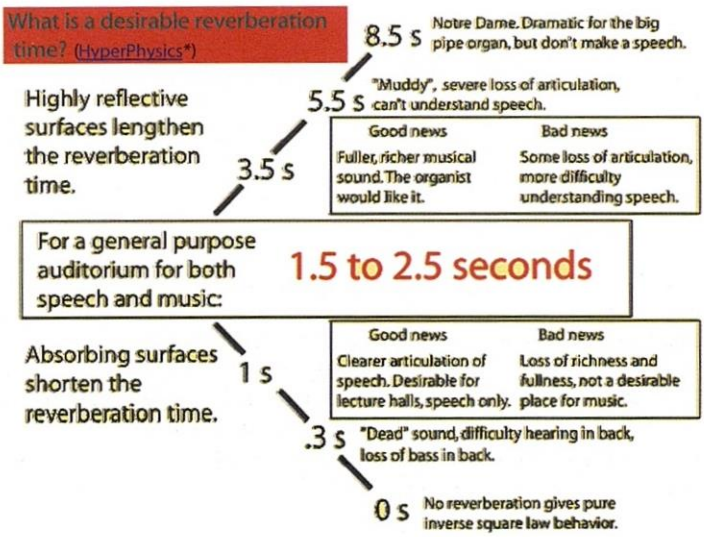
FIGURE 17. Sound Pressure Levels for noise sources measured in the case study. See Fig. 18 for the plotted NC Curves.

Optimum Reverberation Time

As noted reverberation time is defined as the length of time required for sound to decay 60 decibels from its initial level. Lecture rooms should have reverberation times in the range of 0.4-0.6 s, but many existing lecture rooms have reverberation times of 1 second or more. In such cases, the teacher is competing against the lingering reflections of his or her own voice for the student's attention. The result is a chaotic jumble of sounds.

The optimum reverberation time for an auditorium or room of course depends upon its intended use. Around 2 s is desirable for a medium-sized, general purpose auditorium that is to be used for both speech and music. A classroom should be much shorter, less than a second. And a recording studio should minimize reverberation time in most cases for clarity of recording.

The reverberation time is strongly influenced by the absorption coefficients of the surfaces, but it also depends upon the volume of the room as shown in the Sabine formula. You won't get a long reverberation time with a small room.



Material	S(ft²)	a(500Hz)
Tile floor	(25)(30) = 750	0.03
Windows	(2)(5)(7.5) = 75	0.18
Door	(3)(7) = 21	0.09
Chalkboard	(4)(25) = 100	0.01
Plaster (walls and ceiling)	750+(10)(110) -75-21-100 = 1654	0.06

Speech Intelligibility

There are many methods for measuring or predicting speech intelligibility, ranging from a simple A-weighted sound level to the complex Speech Transmission Index (STI). For lecture rooms, speech intelligibility can be predicted from reverberation time and signal-to- noise ratio. A lecture room with a 0.5 second RT and +10 dB S/N will have approximately 90 percent speech intelligibility. If the RT is kept at 0.5 seconds but the S/N is reduced to 0 dB, intelligibility falls to about 55 percent. Similarly, if the S/N is +10 dB but RT is increased to 1.5 seconds, intelligibility drops to around 75 percent. And if the S/N falls to 0 dB and RT is 1.5 seconds, intelligibility falls dramatically to approximately 30 percent. Sadly, this last condition does exist in some U.S. lecture rooms.

Speech intelligibility tests can be used to measure intelligibility in existing lecture rooms. Such tests can take many forms. Typically, a speaker reads nonsense syllables, monosyllabic words, or sentences, and listeners record what they hear, or choose from a list of possible alternatives. The percentage of test items correctly heard is a measure of speech intelligibility. Standardized tests have been developed that outline test procedure, selection of listeners, training of speakers and listeners, and so on. Also available are recordings of standardized word lists that can be reproduced instead of having a speaker read from a list. This eliminates lip reading cues and variations in different speakers' speech characteristics and speech levels. Before beginning actual testing, listeners should practice taking the tests in a quiet environment until they are familiar with the procedure and their scores reach a stable level. (Words used are randomly chosen from a standardized list so listeners cannot simply memorize the order of the words.)

speakers' speech characteristics and speech levels. Before beginning actual testing, listeners should practice taking the tests in a quiet environment until they are familiar with the procedure and their scores reach a stable level. (Words used are randomly chosen from a standardized list so listeners cannot simply memorize the order of the words.)

When testing in a lecture room, the speaker should read the list from the teacher's usual speaking location. To assure conservative results, several listeners should be seated together in whichever area of the lecture room has the poorest signal-to-noise ratio. This is typically in the back, or near the loudest source of mechanical noise. Any noises present during normal lecture room use, such as mechanical noise, outdoor noise, or corridor noise, should be present to ensure representative values of speech intelligibility.

Adults average roughly 10 percent better than young children on speech intelligibility tests. For example, in a first-grade lecture room in which adult listeners score 90 percent, typical students will likely score only 80 percent. Students with hearing or learning disabilities, or for whom English is a second language, will show even lower scores. If speech intelligibility in a lecture room is less than 90 percent, acoustical treatments should be implemented to reduce reverberation and/or improve signal-to-noise ratio.

Noise Criteria Rating

The noise level in a space can be effectively described with a single-number rating called the noise criteria (NC) rating. The NC rating is determined by measuring the sound pressure level of the noise in each octave band, plotting these levels on a graph, and then comparing the results to established NC curves. The lowest NC curve not exceeded by the plotted noise spectrum is the NC rating of the sound. On most graphs, NC curves are shown in intervals of 5 to save space, but the NC rating can be given as any whole number in between, not just as a multiple of 5. To illustrate this, we will find the NC rating for the window air conditioners, unit ventilator, and background noise from the case study presented above. (See Figures 17 and 18)

Sound vs. Distance

We all know that sound level decreases as the distance from a sound source increases. This decrease in sound level is quantified by the inverse square law. That is, the sound energy decrease is proportional to the square of the distance increase. For example, if the listening distance from a sound source is increased by a factor of 2 (doubled), the direct sound energy is decreased by a factor of 4 or 2 squared (2 times 2). This translates to a 6 dB reduction in the sound intensity level and the sound pressure level of the direct sound for each doubling of the distance from the sound source.

Let's assume that, in a particular lecture room, the average difference between the sound level of the teacher's voice and the level of the lecture room background noise produced by the air conditioning system is 10 dB at a student's listening position 10 feet from the teacher. With this 10 dB signal-to-noise ratio the intelligibility of the teacher's speech is probably satisfactory as discussed in the previous section on speech intelligibility. But, if the distance from the teacher to the student is doubled to 20 feet, the signal-to-noise ratio is reduced to about 4 dB (assuming that the background noise remains constant). At a distance of 30 feet the level of the direct sound produced by the teacher is reduced by about 10 dB and the signal-to-noise ratio is 0 dB, with low speech intelligibility. Thus, it is most important that the background noise level be acceptable in all lecture room locations if a proper S/N ratio is to be maintained allowing satisfactory speech intelligibility.

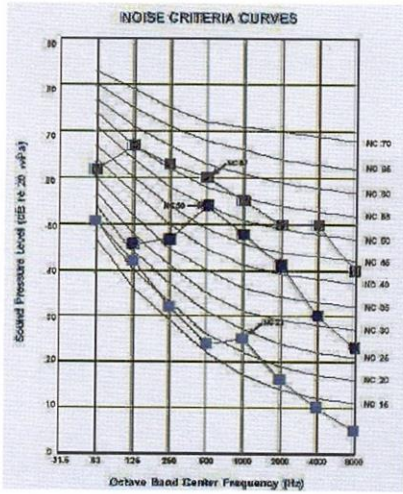
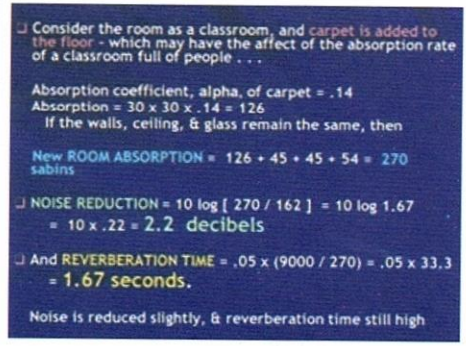


Figure 18. Noise Criteria Rating for the case of study.



Example: Reverbation time calculation.

Fan coil unit
Window AC
Background noise

Table: Absorption Coefficient of Materials (Source: hyperphysics.gsu.edu, 2005)

	Sound Absorption Coefficients at frequency					
Nature of Surface	125	250	500	1000	2000	4000
Acoustic tile, rigid mount	0.2	0.4	0.7	0.8	0.6	0.4
Acoustic tile, suspended	0.5	0.7	0.6	0.7	0.7	0.5
Acoustical plaster	0.1	0.2	0.5	0.6	0.7	0.7
Ordinary plaster, on lath	0.2	0.15	0.1	0.05	0.04	0.05
Gypsum wallboard, 1/2" on studs	0.3	0.1	0.05	0.04	0.07	0.1
Plywood sheet, 1/4" on studs	0.6	0.3	0.1	0.1	0.1	0.1
Concrete block, unpainted	0.4	0.4	0.3	0.3	0.4	0.3
Concrete block, painted	0.1	0.05	0.06	0.07	0.1	0.1
Concrete, poured	0.01	0.01	0.02	0.02	0.02	0.03
Brick	0.03	0.03	0.03	0.04	0.05	0.07
Vinyl tile on concrete	0.02	0.03	0.03	0.03	0.03	0.02
Heavy carpet on concrete	0.02	0.06	0.15	0.4	0.6	0.6
Heavy carpet on felt backing	0.1	0.3	0.4	0.5	0.6	0.7
Platform floor, wooden	0.4	0.3	0.2	0.2	0.15	0.1
Ordinary window glass	0.3	0.2	0.2	0.1	0.07	0.04
Heavy plate glass	0.2	0.06	0.04	0.03	0.02	0.02
Draperies, medium velour	0.07	0.3	0.5	0.7	0.7	0.6
Upholstered seating, unoccupied	0.2	0.4	0.6	0.7	0.6	0.6
Upholstered seating, occupied	0.4	0.6	0.8	0.9	0.9	0.9
Wood seating, unoccupied	0.02	0.03	0.03	0.06	0.06	0.05
Wooden pews, occupied	0.4	0.4	0.7	0.7	0.8	0.7

Revised version

How to Configure Masjid/Lecture Room PA System

The performance of any loudspeaker will be influenced by the acoustics of the space in which they operate. Difficult room acoustics, combined with improper loudspeaker placement, can interfere with achieving the fidelity of which your loudspeakers are capable. This article will guide you around some of the pitfalls when configuring a PA system.

Recognizing Problem Rooms

In most live environments, the room is rarely designed to maximize the listening experience. More often then not, money is spent on aesthetic appeal rather than acoustic treatment. For large-scale tour productions, venues are often sports arenas that have been designed to maximize crowd noise. Smaller music venues are often chosen for location or architectural aesthetics, rather than music reproduction. While an empty warehouse or old wine cellar might make a great environment to hang out in, it's necessary to recognize and correct what that space does to the sound system in order to optimize the PA's performance in the venue.

In general, the following physical features of a room can affect a sound system's performance:

a. Room size, b. Construction, c. Reflectivity

The size of the room directly impacts how well certain frequencies will be reproduced. For example, if you measure a room diagonally, you will discover how well that room will be able to sustain low frequencies. This may seem odd until you think about the physical size of audio waves at various frequencies. For example, a 50 Hz wave is about 22.6 feet long. (To calculate how big an audio wave is, divide the speed of sound—1,130 ft./second—by the frequency. For a 50 Hz wave, 1,130/50 = 22.6 ft.) So a room that is 45 feet on the diagonal is going to regenerate low frequencies more effectively than a room that is 15 feet on the diagonal.

When a room's width or length correlates directly to the size of a waveform at a specific frequency, a standing wave can occur where the initial sound and the reflected sound begin to reinforce each other. Let's say we have a long, narrow room where the distance from one side to the other is 22.6 feet. When a 50 Hz wave bounces off the wall, the reflective wave travels right back along the same path and bounces off the other wall and cycle repeats. In a room such as this, 50 Hz reproduces very well—maybe too well. So any mix will have a heavier low end.

In addition, low-frequency waves are powerful enough to cause the walls, ceiling, and even the floor to flex and move. This is called "diaphragmatic action," and it dissipates energy and strips away the low-end definition. So if you're in an old cotton mill, and the walls and floor are made of thick concrete that don't vibrate much, the bass response is going to be much more powerful than if you've set up a show in an old warehouse where the walls are made of barge board and tin.

Maintain a High Direct-to-Reverberant Ratio

Another way a room interacts with sound waves is through reflectivity. Like most room anomalies, reflections can be good and bad. Consider the effect of a cathedral's reflections on a choir or a piano. This type of reverberation (reverb) is quite desirable. But not all reverb is good reverb. Reflections can also cause comb filtering. For example, if a speaker is placed near a reflective surface (such as a concrete wall), the direct sound coming from the speaker and the reflected sound coming from the wall can arrive at the listener's ears out of phase with each other, causing cancellation and reinforcement. If they're 180 degrees out of phase with respect to each other, they will cancel each other out.

If you are using your loudspeakers in a reverberant environment, position them so that as much sound as possible is focused on the congregation area and steered away from reflective surfaces. When you do your placement and positioning, it's a good idea take some time to do a "walk around" of your loudspeakers, playing either pink noise or program material, so you get a feel for how the sounds are translating into the room.

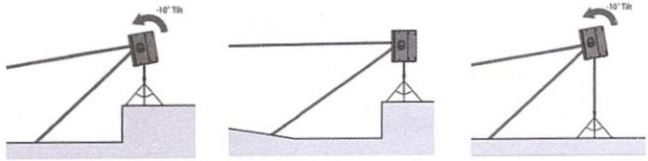
Vertical Coverage

It is important to keep in mind that vertical coverage is just as important as horizontal coverage. If you are using a ground-stack approach with pole mounts, make sure your coverage matches the listening plane. Suspension of speakers will provide even further control.

Important note: Always use a licensed and insured system integrator when suspending loudspeakers. These individuals are not only trained to know how to safely suspend heavy loudspeakers, they also know how to hang them so they sound their best.

? PreSonus StudioLive™ AI-series PA speakers are used as examples in this article. Read more about how this affects coverage.

Some loudspeakers, like the StudioLive 312AI and 328AI full-range loudspeakers, feature dual-position pole mounts that allow you to mount the speaker atop a stand at 90 degrees or at a 7 to 10-degree downward tilt. (The StudioLive 315AI does not offer a downward tilt.) Using the downward-tilt mount will focus the loudspeaker's energy onto the audience and avoid destructive reflections. This is ideal for situations where the loudspeaker is mounted atop a tripod stand and placed on a stage or where the pole-mounted loudspeaker is on the floor and the coverage area is relatively shallow (conference, coffee house, etc.)



Flat floor with stage. Elevated floor with stage. No stage, flat floor.

Wall and Corner Loading

Very low frequencies are not directional, so they radiate out of the sides and back of the loudspeaker, as well as out of the front. If you place a loudspeaker against a wall, the rear sound propagates back into the room. This can increase output of bass frequencies as much as 6 dB, and as much as 12 dB if you put the loudspeaker in a corner.

In order to have the most control over your sound, it's best to always start with the flattest response, so you normally should avoid wall and corner placement. On the other hand, if you need some extra bass boost, this technique may be worth a try. It is important to be aware of what's happening and be prepared to take advantage of it or compensate for it.

Delay Systems

In most situations, a PA system relies on two main speaker systems positioned at the front of the room to reproduce audio for the entire performance space. As a result, the level of the system is considerably louder at the front line then it is at mix position.

With a point-source, horn-loaded loudspeaker (such as a single, powered loudspeaker), sound intensity is lost at a rate of -6 dB per doubling of distance. This is true regardless of tuning, amplification, power rating, or any other speaker specifications. So if your signal level is 118 dB SPL at 1 foot, at 8 feet away it's down by 18 dB!

Here's a simple chart that illustrates the math:

Distance	dB SPL	Distance	dB SPL
1 ft.	118 dB	8 ft.	88 dB
2 ft.	100 dB	16 ft.	82 dB
4 ft.	94 dB	32 ft.	76 dB

In situations where sound must be reproduced outside of the main system's optimum range, well-placed delay systems offer support by extending the intelligible range of the PA. Rather than relying on a pair of front-of-house speakers to fill the entire room, you can create listening zones throughout the room so that your front-of-house system only needs to be loud enough to cover the front of the room. This allows you to lower the level, giving the front-row listeners' ears a break and getting better fidelity from your speakers.

However, it's not as easy as just bringing an extra pair of speakers. Since electricity travels much faster than sound, listeners in the rear of the room are likely to hear the sound coming from the nearest set of speakers before they hear the sound from stage, which can dampen the attack and intelligibility of the sound and create an unpleasant phasing effect.

To compensate, you need to delay the signal going to the additional speakers. For example, it takes about 55 ms for sound to travel 50 feet. So if you put your speakers 50 feet back, you need to delay the signal by that much.

Fortunately, with StudioLive AI-series loudspeakers and SL Room Control, you can delay each speaker by up to 300 ms. All you need is a reasonably accurate measurement of the distance between your main speakers and delays.

Also note that if you are using conventional loudspeakers with a StudioLive-series digital mixer, you can use the mixer's subgroup outputs, each of which has a variable delay of up to 300 ms, to feed your satellite (delay) speakers.

If neither your mixer nor your loudspeaker has a built-in delay, use a separate delay processor to achieve the same results.

Delay Basics

Delay speakers allow you to run the main speakers at a lower volume, as they relieve the mains of handling high- and mid-frequency content for part of the space. As a speaker is pushed harder, the edges of its frequency response begin to distort, so by easing the demands on the mains, delay systems increase fidelity sonically, as well as mechanically. This also means that the front row doesn't need to be blasted just so the people at the back can hear the show.

The goal of distributed sound is to extend the intelligible range of the system, without killing the front of the crowd with excessive level. As noted earlier, sound travels much slower than electricity, so the audio coming out of the delay system will arrive to the listeners before the audio coming out of the main system. Without proper alignment, the multiple arrival times create confusion to the listener and sonic definition is lost. Speech and beat transients become less intelligible. In large venues, this can actually create a flam or echo effect. By delaying the audio going to side and rear fills, you can create a cohesive listening environment for the entire audience.

It should be noted that frequencies in the sub-bass range of a delay system do not require distribution. In fact, a delay system's highpass filter should be rolled up as high as 300 to 400 Hz to avoid sound going back toward the stage as low frequencies become omnidirectional.

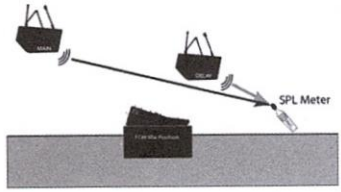
When placing delay systems, the main goal is to maintain intelligibility of the PA, especially in the vocal consonant range (2 to 4 kHz). However, this goal is achieved by overcoming different obstacles depending on whether you are indoors or outdoors. In both situations, the delay system should be set where the main system's intelligibility falls apart. As with the main system, the placement of the delay systems will determine how successfully you are able to achieve these goals.

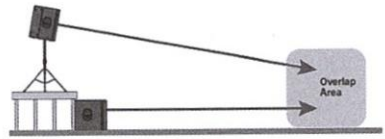
Inside. Indoors, you are trying to overcome the direct-to-reverberant reflections. The location of the delay system is dependent on the critical listening area (typically just behind front-of-house). Your goal is to find where the direct signal-to-reverberation ratio has reached about 50/50. At this point, the reflections in the room are at an equal level to the direct sound of the PA, and vocal intelligibility is lost. Listen for a lack of intelligibility in the vocals and find the point at which the drums and rhythm section don't feel tight.

A great way to find the best position for your delay speakers is to set up and tune your main system and play audio through it. Play something similar to what you will be mixing later. Set the level so that it is comfortable from the front row. Walk backward away from the main system until you notice a lack of clarity. This is the beginning of the space that will need delay-system coverage.

Outside. Outdoors, you are trying to maintain level as the noise floor of the crowd begins to be at equal level to the PA in the intelligibility range. When working outside, the delay system is used to overcome outdoor noise, including (but not limited to) crowd murmur, concessions, generators, tractors, babies, etc. At this point, the main system needs more support in order to deliver the same perceived loudness as you get further from the source.

Once you have positioned and delayed your satellite system, use an SPL meter to match the output of the main and delay systems at the measurement point. If you are standing 20 feet from the left side of the main system and 30 feet from the left side of the delay system, and if the output of the main system is 85 dB, the output of the delay system should also be 85 dB.





Read more about aligning the StudioLive 18sAI subwoofer.

Sub Alignment

Delaying subwoofers relative to their full-range counterparts compensates for the cancellation or reinforcement of low frequencies that occurs when the same frequencies are reproduced by two sound sources set some distance apart. Low frequencies in the crossover region between full-range and subwoofer have wavelengths that are several feet long—the wavelength of a 150 Hz wave is about 7.5 feet—which means that reinforcement and cancellation will occur as the waves interact in the room.

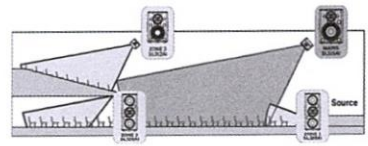
Delaying a subwoofer will compensate for this effect when the loudspeaker is about the same distance away from, or in front of, the subwoofer, as specified in the setting. As room acoustics will influence effectiveness, we recommend listening tests using different delay settings, in conjunction with alternate polarity settings, to determine the best results.

If you are aligning for a custom installation you will need to do some calculating:

Find the spot in the room where coverage from the main speakers and the subwoofers overlap. Measure the distance from the overlap area to each speaker location. Subtract the smaller distance from the larger. Divide that number by 1,100 and apply that delay value to the speaker that is closest. Keep in mind that the overlap area may be behind front-of-house.

Real-World Delay System Example

The goal in a complicated system with loudspeakers distributed throughout the venue is to delay each satellite system to its counterpart in the main system (e.g., the left front fill to the left front-of-house loudspeaker).



- Delay the main system relative to the source on stage. On small stages where the guitar amp and drum kit can be clearly heard above the front-of-house (FOH) loudspeaker system, delaying the main system can "move up" the backline so that it aligns with these instruments and decreases blurring in the mix. This will tighten the overall mix and give it more punch.
- Delay the front fills relative to the main system by delaying each side of the system independently (e.g., delay the left front fill to the left FOH loudspeaker).
- Delay subwoofers relative to the main system. How you do this will depend on how your subwoofer system is positioned and configured. In general, you will want to delay each subwoofer relative to the full-range loudspeaker closest to it.
- Delay down-fill speakers (upper and under balcony) relative to the main system, again delaying each side of the system independently.

System Configuration Suggestions

The following discussion and graphics will demonstrate some system configurations for common rooms. The size and shape of your room and the application for which it will be used determine, to a large extent, how many speakers you will need and where they should be placed. In every situation, keep in mind two important design factors: your loudspeaker's coverage pattern and half-space loading.

Every full-range StudioLive AI loudspeaker offers a 90° horizontal x 60° vertical coverage pattern. If you are using StudioLive AI-series speakers, be sure to pay close attention to these angles when using your speakers. Rotating the cabinet changes the horizontal and vertical coverage. If you are using conventional (non-coaxial) loudspeakers, find out what their coverage pattern is and figure accordingly.

When configured for stereo use, make sure the cabinets are not placed too wide for the room or too far back into the corners. Too wide of a placement will direct too much energy onto the walls and can potentially add destructive interference to the room. Adjust the left and right speakers, as well as the toe-in angle, to produce the best stereo image. If a room is very narrow, a mono cluster might be a better choice than stereo.

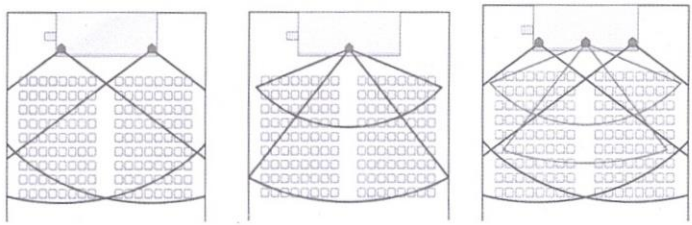
Wherever you place your loudspeakers, you should be aware of half-space loading. Half-space loading occurs when a speaker comes in close contact with, or touches, a hard surface like a floor or wall. As its name indicates, this type of summation happens when the circular radiation of the speaker is blocked by a hard surface and forced to radiate in a crescent shape. Depending on the proximity and position, there may be a boost in low-frequency energy. Testing your speaker placement and doing some critical-listening tests will help determine the best final location for your loudspeaker system.

If your speakers are sitting on the floor, you can expect a certain amount of half-space loading. If you are using your speakers as floor wedges, you might want to experiment with using a highpass filter (built into all full-range StudioLive AI loudspeakers) to reduce low energy. In some cases, this might improve intelligibility. Using the Floor Monitor DSP contour will also help you get the best use out of StudioLive AI loudspeakers in this position.

Note: Because a floor monitor placed on the stage is unavoidably subject to half-space loading, the Monitor DSP contour in a StudioLive AI-series full-range loudspeaker is specifically designed to compensate for bass buildup and maintain a tight mid-bass response.

Stereo System

A stereo system allows panning and adds depth to the acoustic image. This is good for speech reinforcement and greatly enhances live or pre-recorded music. Locate speakers to give the best horizontal coverage. Ensure that the listeners are well covered by the pattern.



Stereo Mono Cluster LCR

Mono Cluster with Down Fill

Center or mono systems can provide a simple, economical solution for venues where speech intelligibility is the priority, rather than music. As with a stereo system, make sure the coverage pattern of the speaker focuses the energy on the audience.

This graphic actually shows two speakers. The upper speaker is for throwing to the back of the room, and the lower speaker covers the space in the front of the room, closest to the stage.

LCR Systems

An LCR system is a stereo system with a center speaker added. This configuration allows panning and adds depth to the acoustic image. This type of system will provide more control than a basic stereo system and is ideal in situations where music and speech intelligibility are equally important.

Measurement of acoustical characteristics of mosques in Saudi Arabia

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The study of mosque acoustics, with regard to acoustical characteristics, sound quality for speech intelligibility, and other applicable acoustic criteria, has been largely neglected. In this study a background as to why mosques are designed as they are and how mosque design is influenced by worship considerations is given. In the study the acoustical characteristics of typically constructed contemporary mosques in Saudi Arabia have been investigated, employing a well-known impulse response. Extensive field measurements were taken in 21 representative mosques of different sizes and architectural features in order to characterize their acoustical quality and to identify the impact of air conditioning, ceiling fans, and sound reinforcement systems on their acoustics. Objective room-acoustic indicators such as reverberation time (RT) and clarity (C_{50}) were measured. Background noise (BN) was assessed with and without the operation of air conditioning and fans. The speech transmission index (STI) was also evaluated with and without the operation of existing sound reinforcement systems. The existence of acoustical deficiencies was confirmed and quantified. The study, in addition to describing mosque acoustics, compares design goals to results obtained in practice and suggests acoustical target values for mosque design. The results show that acoustical quality in the investigated mosques deviates from optimum conditions when unoccupied, but is much better in the occupied condition.
[DOI: 10.1121/1.1531982]

Visit for full article:

https://www.researchgate.net/publication/10839602_Measurement_of_Acoustical_Characteristics_of_Masjids_in_Saudi_Arabia

Waste Management

General Waste Operating Procedure

1. Scope

This operating procedure covers the general waste stream at IIUC.

2. Objectives

- To avoid risk to health and safety;
- To ensure the University grounds are aesthetically pleasing;
- To avoid incidence of littering;
- To ensure that the waste is disposed of in an environmentally acceptable manner; and
- To avoid waste to landfill and associated CO_2e emissions.

3. Procedures

3.1 Waste Minimisation Strategies

A recycling scheme is in place. For further information, please see the Recycling procedure below.

3.2 Sorting

It is the responsibility of the individual users to sort and dispose of their waste thoughtfully. There are appropriate bins for the general waste stream placed throughout the grounds and inside buildings.

3.3 Collection from Source

It is the responsibility of the Cleaning Services of the LMD to ensure: the following:

- That the general wastes are collected in 240 liter larger bins or other appropriate waste bins;
- That the general wastes collected are taken to a kerbside position for collection; and
- Upon servicing, the bins are returned from the kerbside to their original position.

3.4 Collection for Disposal

It is the responsibility of the Cleaning Services of the Property and Facilities Division to ensure the following:

- That cleaners collect the wastes from wheelie bins placed on the kerbside as per arrangements;
- That the general wastes are disposed of in landfills approved by Local Authori ties; and General Waste site at IIUC.

3.5 Disposal Frequency

* Public Areas

Public and student related areas are cleaned and general waste removed every day Saturday to Thursday

- **Offices**

Most general offices are scheduled to be cleaned and general waste removed once/twice per week.

The disposal of garbage such as food scraps which occupants do not wish to keep in their office bin until the scheduled cleaning day, should be placed in dedicated larger bin with higed lid that are located within buildings.

If office occupant's bins become full prior to the day of collection, the occupant can empty their office bin into the larger bin with hinged lid located within their building.

4. Equipment

The equipment for collection of general wastes consists of:

- Small desk waste bins for general office use;
- 240 liter bins for collection of waste by cleaners;
- 240 liter bins located around the grounds for waste collection; and
- Cylindrical bins located around the grounds for waste collection.

Recycling Operating Procedure (Future Plan)

1. Scope

This policy applies to the following recycling streams at The University of Queensland campus:

Paper; Cardboard; Polystyrene, Toner and Ink Jet Printer Cartridges; Mobile Phones; E-Waste (computers and other electronic equipment).

Florescent tubes and other lamps; and Co-mingled (aluminium, glass, and plastics).

2. Objectives

IIUC should seek to minimise the waste going to landfill through recycling initiatives.
IIUC's future policy should be to promote recycling of materials by having in place a comprehensive recycling scheme to:

- Reduce the output of the general waste stream;
- Minimise contamination in the recycling stream;
- Reduce the need for landfill space;
- Take advantage of the economic benefits arising from recycling;
- Promote resource conservation of non-renewable and renewable resources; and
- Reduce CO2 emissions associated with waste to landfill.

3. Procedure (to be followed when ready)

Please sort and dispose of your recyclables thoughtfully.

Appropriate receptacles for select recycling categories are to be placed throughout the University's buildings and grounds.

Additional Information

Time it takes for garbage to decompose in the environment

Information: US National*

Glass Bottle	1 million years
Monofilament Fishing Line	600 years
Plastic Beverage Bottles	450 years
Disposable Diapers	450 years
Aluminum Can	80-200 years
Foamed Plastic Buoy	80 years
Foamed Plastic Cups	50 years
Rubber-Boot Sole	50-80 years
Tin Cans	50 years
Leather	50 years
Nylon Fabric	30-40 years
Plastic Film Container	20-30 years
Plastic Bag	10-20 years
Cigarette Butt	1-5 years
Wool Sock	1-5 years
Plywood	1-3 years
Waxed Milk Carton	3 months
Apple Core	2 months
Newspaper	6 weeks
Orange or Banana Peel	2-5 weeks
Paper Towel	2-4 weeks

Rick LeBlanc Updated February 28, 2017

Cigarette Butts	10-12 years
Monofilament Fishing Line	600 years
Rubber-Boot Sole	50-80 years
Foamed Plastic Cups	50 years
Leather shoes	25-40 years
Milk Cartons	5 years
Plywood	1-3 years
Painted board	13 years
Cotton Glove	3 months
Cardboard	2 months
Styrofoam	It does not biodegrade
Nylon Fabric	30-40 years
Tin can	50 years
Ropes	3-14 months
Waxed milk carton	3 months
Aluminum cans	200-250 years
Train tickets	two weeks
Canvas products	1 year
Batteries	100 years
Lumber	10-15 years
Sanitary Pads	500-800 years
Wool Clothing	1-5 years
Tinfoil	It does not biodegrade.

**Information Source: U.S. National Park Service; Mote Marine Lab, Sarasota, FL.*
***Different sources have different information on actual time various waste items take in landfills to decompose. But the numbers don't vary much.*

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